

M3535A/M3536A  
Instructions for Use



## HeartStart MRx



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NOTE: To obtain *Instructions for Use* for previous versions of the HeartStart MRx, visit the Philips Documentation and Downloads web site at <http://www.medical.philips.com/main/products/defibrillation> and look for part number M3535-91900.

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U.S. FEDERAL LAW RESTRICTS THIS DEVICE TO SALE ON OR BY THE ORDER OF A PHYSICIAN.

## Medical Device Directive

The HeartStart MRx complies with the requirements of the Medical Device Directive 93/42/EEC and carries the **CE**<sub>0123</sub> mark accordingly.

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For the Declaration of Conformity Statement, please see the Philips Medical web site at <http://incenter.medical.philips.com/PMSPublic>. Scroll over the Quality and Regulatory Tab located in the upper left corner of the window. Click to select Regulatory by Modality. Then click to select Defibrillators and select the entry for Declaration of Conformity (DoC).

## Warning

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

These Instructions for Use contain the following conventions:

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**WARNING** Warning statements describe conditions or actions that can result in personal injury or loss of life.

---

**CAUTION** Caution statements describe conditions or actions that can result in damage to the equipment or loss of data.

---

**NOTE** Notes contain additional information on usage.

<b>"Voice"</b>	represents voice prompt messages
<b>Text</b>	represents messages that appear on the display
<b>[Soft key]</b>	represents soft key labels that appear on the display above the button to which they correspond.

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# Introduction

Thank you for choosing the HeartStart MRx monitor/defibrillator. Philips Medical Systems welcomes you to its family of resuscitation devices.

The HeartStart MRx is designed to meet your monitoring and resuscitation needs by providing advanced, multi-parameter monitoring functions and a full range of defibrillation therapies. This guide provides instructions for the safe and proper operation of the device, as well as set-up, configuration, and maintenance information.

Be sure to familiarize yourself with the features and operation of the HeartStart MRx prior to its use.

## Overview

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

In Monitor Mode you can monitor up to four ECG waveforms, acquired through a 3-, 5-, or 10-lead ECG set. Optional monitoring of pulse oximetry (SpO<sub>2</sub>), noninvasive blood pressure (NBP), carbon dioxide (EtCO<sub>2</sub>), temperature, and invasive pressure are also available. Measurements from these parameters are presented on the display. Alarms are available to alert you to changes in the patient's condition. You can also display a Vital Signs Trending Report to view all key parameters and their measurements at a glance.

Monitor Mode also provides an optional 12-Lead ECG function, enabling you to preview, acquire, store, and print 12-lead ECG reports, with or without analysis/interpretation. You can also transmit 12-Lead reports via the 12-Lead ECG Transmission option.

Manual Defib 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 Defib Mode also allows you to perform synchronized cardioversion and internal defibrillation. If desired, use of Manual Defib Mode may be password protected.

In AED Mode, the HeartStart MRx 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 on the display.

The Manual Defib and AED modes incorporate the Philips' low energy SMART Biphasic waveform for defibrillation. Both modes also offer the Q-CPR™ option. Q-CPR offers real-time, measurement and corrective feedback on the rate, depth, and duration of CPR compressions, as well as the frequency and volume of ventilations. It also provides notification of lack of CPR activity. The two modes also have an optional Audio function which allows you to record audio during a patient incident.

Optional Pacer Mode offers noninvasive transcutaneous pacing therapy. Pace pulses are delivered through multifunction electrode pads, using a monophasic waveform. If desired, use of Pacer Mode may be password protected.

The HeartStart MRx is powered by rechargeable lithium ion batteries. Available battery power is easily determined by viewing the convenient battery power indicators located on the device display or by checking the gauge on the battery itself. Additionally, an external AC or DC Power Module may be applied as a secondary power source and for continual battery charging.

The HeartStart MRx performs Automated Tests on a regular basis. The results of these tests are reported to the Ready For Use (RFU) indicator. The prominently displayed RFU indicator communicates the status of your device, letting you know it is operating correctly, needs attention, or is unable to deliver therapy. In addition, performing the specified Operational Check ensures that the HeartStart MRx is functioning properly.

The HeartStart MRx automatically stores critical event data, such as Event Summaries, 12-Lead Reports and Vital Signs Trending, in its internal memory. The HeartStart MRx also enables you to store data and event information on an optional data card for downloading to Philips' data management solution, HeartStart Event Review Pro or Q-CPR Review.

The HeartStart MRx is highly configurable to better meet the needs of diverse users. Be sure to familiarize yourself with your device's configuration before using the HeartStart MRx. See Chapter 17 "Configuration" for more details.

## Intended Use

The HeartStart MRx is intended for use in hospital and pre-hospital settings by qualified medical personnel trained in the operation of the device and qualified by training in basic life support, advanced cardiac life support or defibrillation.

When operating as a semi-automatic external defibrillator in AED Mode, the HeartStart MRx is suitable for use by medical personnel trained in basic life support that includes the use of an AED.

When operating in Monitor, Manual Defib or Pacer Mode, the HeartStart MRx is suitable for use by healthcare professionals trained in advanced cardiac life support.

The SMART Biphasic waveform utilized in the HeartStart MRx has previously undergone clinical testing in adults. These trials support the waveform's effectiveness for defibrillation of ventricular tachyarrhythmias at 150J. There are currently no clinical studies related to the use of the SMART Biphasic waveform in pediatric applications.



## Indications for Use

The HeartStart MRx is for use for the termination of ventricular tachycardia and ventricular fibrillation.

The device is for use by qualified medical personnel trained in the operation of the device and qualified by training in basic life support, advanced cardiac support, or defibrillation. It must be used by or on the order of a physician.

### AED Therapy

To be used in the presence of a suspected cardiac arrest on patients of at least 8 years of age that are unresponsive, not breathing and pulseless.

### Manual Defibrillation

Asynchronous defibrillation is the initial treatment for ventricular fibrillation and ventricular tachycardia in patients that are pulseless and unresponsive. Synchronous defibrillation is indicated for termination of atrial fibrillation.

### Noninvasive External Pacing Therapy

The pacing option is intended for treating patients with symptomatic bradycardia. It can also be helpful in patients with asystole, if performed early.

### Pulse Oximetry

The SpO<sub>2</sub> option is intended for use when it is beneficial to assess a patient's oxygen saturation level.

### Noninvasive Blood Pressure Monitoring

The NBP option is intended for noninvasive measurement of a patient's arterial blood pressure.

### End-tidal CO<sub>2</sub>

The EtCO<sub>2</sub> option is intended for noninvasive monitoring of a patient's exhaled carbon dioxide and to provide a respiration rate.

### 12-Lead ECG

The 12-Lead ECG function is to provide a conventional diagnostic 12-Lead ECG report, which may include measurements and interpretative statements.

## Q-CPR

The Q-CPR™ option provides feedback designed to encourage rescuers to perform resuscitation in accordance with AHA/ERC guidelines for chest compression rate, depth, and duty cycle and ventilation rate, volume and flow rate (inflation time).

The Q-CPR option is contraindicated as follows:

- The Q-CPR option is contraindicated for use on neonatal and pediatric patients (under 8 years of age or weighing less than 25 kg).
- The Q-CPR option is not for use when CPR is contraindicated.

## Invasive Pressures

The Invasive Pressures option is indicated for measuring arterial, venous, intracranial and other physiological pressures on patients.

## Temperature

The Temperature option is indicated for measuring temperature in patients.

# Safety Considerations

General warnings and cautions that apply to use of the HeartStart MRx are provided in “Specifications and Safety” on page 273. Additional warnings and cautions specific to a particular feature are provided in the appropriate section of this guide.

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**WARNING** Electric shock hazards exist internally. Do not attempt to open the device. Refer servicing to qualified personnel.

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**WARNING** Use only supplies and accessories approved for use with your HeartStart MRx. Use of non-approved supplies and accessories could affect performance and results.

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**WARNING** Use single-use supplies and accessories only once.

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## Documentation and Training

Available documentation and training for the HeartStart MRx includes:

- HeartStart MRx Instructions for Use
- HeartStart MRx Quick Reference Cards
- HeartStart MRx Battery Application Note
- HeartStart MRx Improving ECG Quality Application Note
- HeartStart MRx Web-based User Training (Located at:  
[www.medical.philips.com/goto/mrxtraining](http://www.medical.philips.com/goto/mrxtraining). Enter training access password: meetMRx.)
- HeartStart MRx User Training Videotape and DVD

Other Application Notes can be found on the Philips website at:  
[www.medical.philips.com/goto/productdocumentation](http://www.medical.philips.com/goto/productdocumentation).



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# Getting Acquainted

The HeartStart MRx is designed with your needs in mind. Controls, indicators, and menus are carefully organized to facilitate ease of use. Display information is tailored to the current task.

This chapter will acquaint you with the HeartStart MRx operational modes, display views, controls, and indicators. It also provides general information on use of the device.

**NOTE** If your HeartStart MRx does not have some of the optional functionality listed in this chapter, disregard these controls and the related information described throughout this manual.

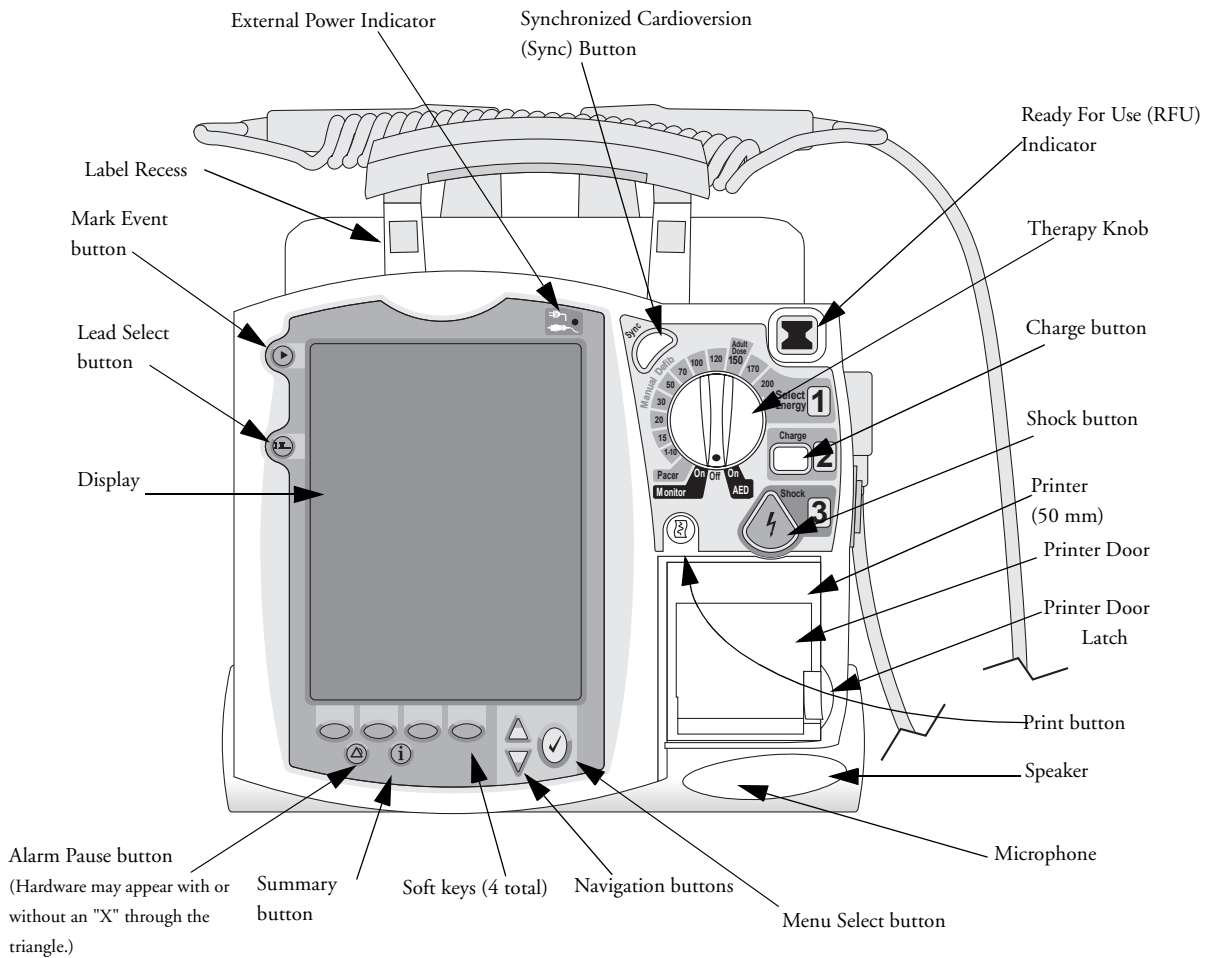
# Basic Orientation

HeartStart MRx controls, indicators, and connections are carefully organized for ease of use.

## Front Panel

The front panel contains operational controls and indicators, as shown below.

**Figure 1 Basic Orientation (Front)**



Additional controls and indicators are on the paddles (if used) and batteries.

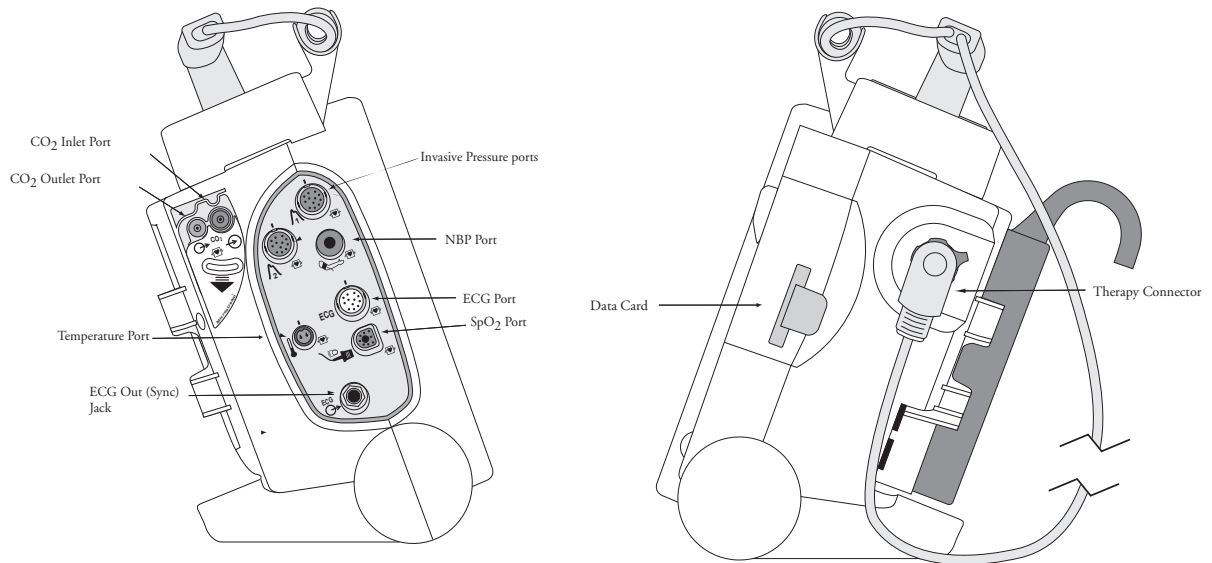
**NOTE** A palette of colored decals is included with your HeartStart MRx. These colored decals may be applied to the label recesses located on the device handle to aid in identification. Use an indelible marker to print identification information on the decal.

## Side Panels

The left side of the HeartStart MRx has ports for monitoring cables, including ECG, pulse oximetry (SpO<sub>2</sub>), noninvasive blood pressure (NBP), invasive pressure (2), temperature and carbon dioxide (CO<sub>2</sub>). The ECG port may be used to connect a 3-, 5-, or 10-lead patient cable. The ECG Out jack may be used to connect to an external monitor.

The right side of the HeartStart MRx has a therapy port for paddles (external or internal) or multifunction electrode pads. It also has a slot for a data card to transfer patient information.

**Figure 2 Basic Orientation (Right/Left Sides)**

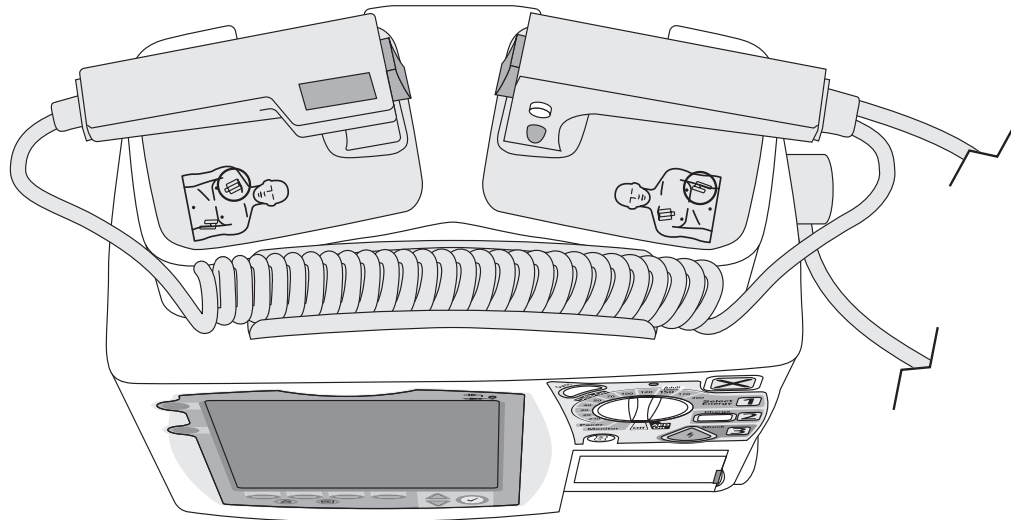


**NOTE** Some devices may also have an RJ11 telephone jack on the left side. The RJ11 telephone jack is not used by the HeartStart MRx.

## Top Panel

The top of the HeartStart MRx has a handle and basic operating instructions. If optional external paddles are present, they reside on the top panel as shown.

**Figure 3 Basic Orientation (Top - with Optional Paddles)**



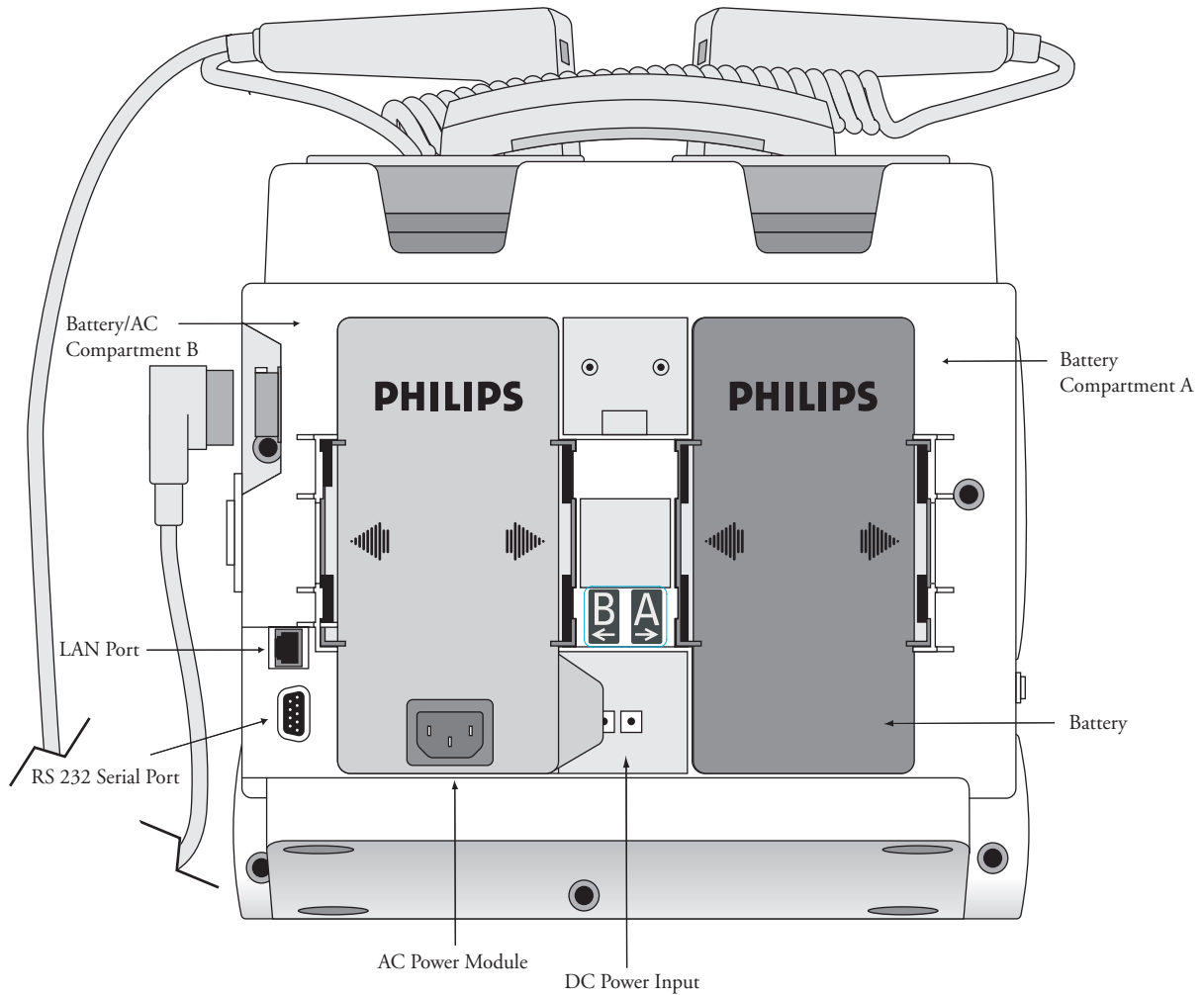


## Back Panel

The back panel of the HeartStart MRx has two compartments for lithium ion batteries. Compartment B may instead be used to connect an AC power module. Between the battery compartments is a DC Power Input port.

The back panel also has an RS 232 serial port for 12-lead ECG transmission.

**Figure 4 Basic Orientation (Back)**



# M3538A Lithium Ion Battery

The HeartStart MRx uses the M3538A Lithium Ion Battery. The battery has a fuel gauge with 5 LED indicators, each representing a charge of approximately 20% of capacity. Press the fuel gauge button to illuminate the fuel gauge.

**CAUTION** A battery should be used as the primary power source. AC/DC should be used as a secondary source, if desired. If an AC/DC power module is used as the only power source, the HeartStart MRx takes longer to charge to the desired energy level and, in the event of power loss, all settings reset to the default settings and a new incident is created when power is returned. All stored data remains intact and can be found by retrieving the previous incident. Keep your unit charged.

## Battery Capacity

A new, fully-charged M3538A battery, operating at room temperature 25°C(77°F), provides approximately 5 hours of monitoring, with ECG, SpO<sub>2</sub>, CO<sub>2</sub>, temperature, two invasive pressures monitored continuously, NBP measured every 15 minutes, and 20 200J discharges. A fully charged new battery provides approximately 3.5 hours of monitoring, with ECG, SpO<sub>2</sub>, CO<sub>2</sub>, temperature, two invasive pressures monitored continuously, NBP measured every 15 minutes, and pacing at 180ppm at 160mA.

## Battery Life

Battery life depends on the frequency and duration of use. When properly cared for, the M3538A Lithium Ion battery has a useful life of approximately 2 years. To optimize performance, a fully (or nearly fully) discharged battery should be charged as soon as possible.

## Operating Modes


The HeartStart MRx has four clinical modes of operation, each with a customized display view. The modes are as follows:

**Table 1 Operating Modes and Views**

Mode of Operation	Display View	Description
Monitor Mode	Monitoring View, or 12-Lead View	Used to monitor ECG, take an optional 12-lead ECG, and monitor optional parameters such as SpO <sub>2</sub> , EtCO <sub>2</sub> , NBP, Invasive Pressures, Temperature and for viewing Vital Signs Trending data.
AED Mode	AED View	Used to analyze ECG and if necessary, perform semi-automatic external defibrillation. Q-CPR available.
Manual Defib Mode	Code View	Used to perform asynchronous and synchronous defibrillation (cardioversion). Q-CPR available.
Pacer Mode	Pacing View	Used to perform demand or fixed mode pacing.

**NOTE** Upon returning to a clinical mode from a non-clinical mode such as Configuration or Data Management, all settings reset to the default settings.

## Password Security

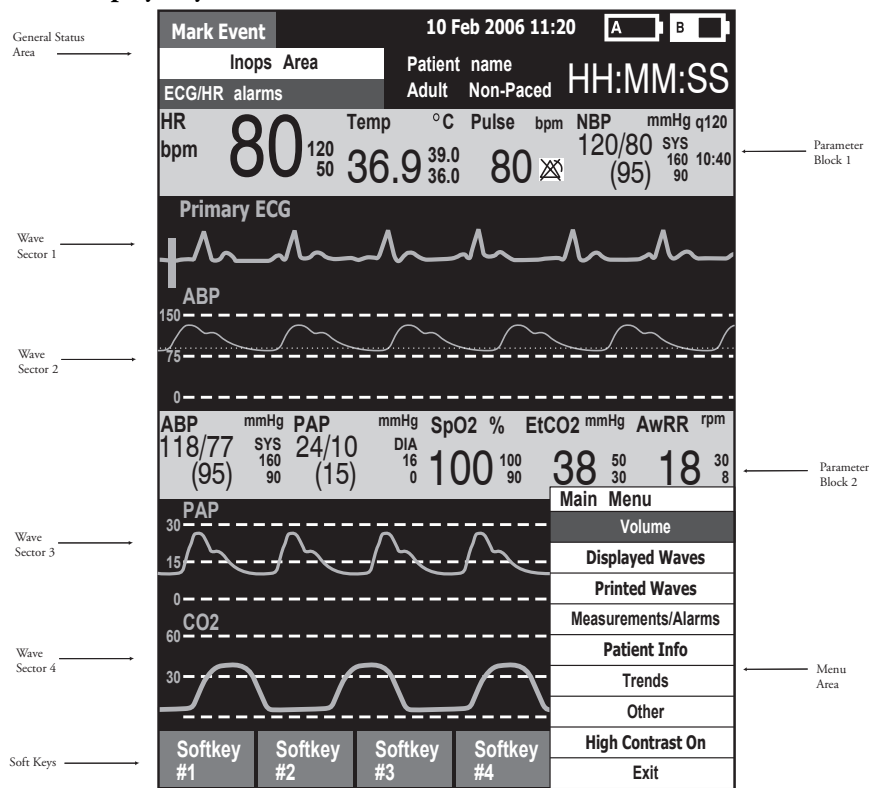
Access to Manual Defib Mode and Pacer Mode may be password protected if configured. If enabled, you will be prompted to enter the password upon moving the Therapy Knob to either the Pacer position or an energy selection. The password is entered by using the Navigation buttons to select the password numbers and then selecting **Done** to complete the entry. The Charge  button and the **[Start Pacing]** soft key remain inactive until the password is entered. AED mode is always available without a password.

**WARNING** Use of the Manual Therapy security password requires the clinician to know and remember the password, as defined in Configuration. Failure to enter the correct password will prevent the delivery of manual defibrillation or pacing therapy. Prior to selecting this Configuration option, review this potential risk with your Risk Manager.

## Display Views

The HeartStart MRx display layout is segmented as shown in Figure 5.

**Figure 5 Display Layout**



**NOTE** Pictures of the HeartStart MRx display appearing in this manual are for illustration purposes only. The content of these areas varies with the display view, the options on your device and the function being performed.

## General Status

The general status area of the display contains:

- Mark Event button label
- Date and time
- Audio recording icon. If the option is enabled, one of the audio recording icons is displayed to the left of the battery icons in all clinical modes to indicate the status of audio recording.
- Battery power indicators
 

Battery icons, labeled “A” and “B”, correspond with the battery compartments located at the back of the HeartStart MRx. Each battery icon displays the current available battery power, ranging from hollow (fully discharged) to full (fully charged), as shown in Figure 6. If the AC Power Module is inserted in Compartment B, the no battery icon is displayed.

**Figure 6 Battery Charge Level Indicators**



- INOP statements
 

INOP statements appear in the top left of the display if equipment problems are detected.
- ECG/HR alarm status
 

Alarm messages communicate arrhythmia alarms, as well as overall alarm status (alarms off, alarms paused).
- Patient information
 

Some modes of operation allow for the entry of patient information via a menu choice. If no information is entered, the patient category is defaulted to **Adult**, unless configured otherwise, and the pacing status is set to **Non-Paced**, unless the Paced status has been previously set to paced for an internally paced patient or the HeartStart MRx is pacing the patient. In Pacer Mode, Paced status is not displayed.
- Patient Name. If entered, the patient’s name will appear above the patient type and paced status.
- Event Timer
 

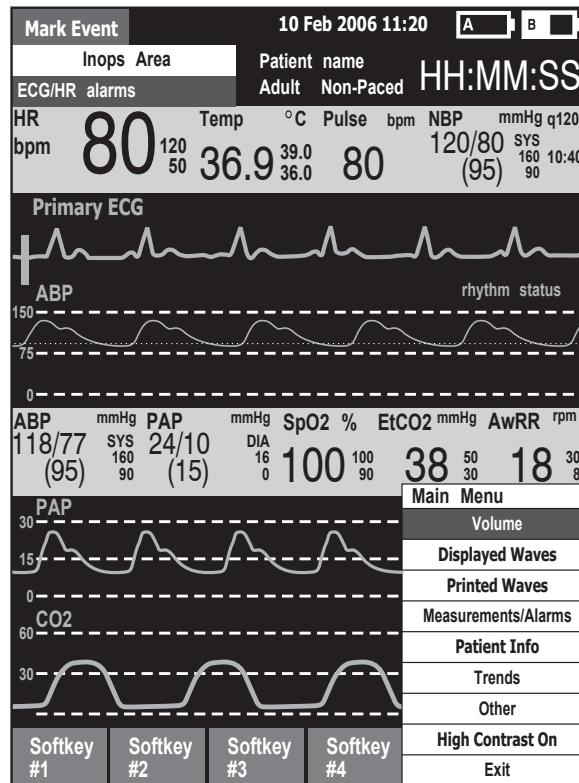
An Event Timer communicates the elapsed time for the current patient incident.

## Wave Sectors

The HeartStart MRx is configured to populate each wave sector with a predetermined waveform, when powered on in Monitor, Manual Defib, or Pacer Mode. Figure 7 shows the default Waves configuration choices for a device containing all monitor options. See “Configuration” on page 181 for more information.

A dashed line in a wave sector or an empty wave sector indicates that the waveform source is invalid. Wave sectors may contain a variety of information, as appropriate to the parameter, view, and task.

**Figure 7 Default Waves Configuration**



### Wave Sector 1

Wave Sector 1 will only contain an ECG waveform. This is the waveform used by the arrhythmia, heart rate derivation, and AED analysis algorithms.

If Pads are configured as the primary ECG source for Wave Sector 1, the ECG patient cable must be connected to the HeartStart MRx and to the monitoring electrodes on the patient in order to change the ECG source to a Leads selection.

**NOTE** When monitoring using a 3-lead ECG set, the HeartStart MRx displays 1 ECG lead at a time.


## Wave Sectors 2-4

Wave Sectors 2 through 4 are automatically populated when parameter sources (cables/tubing) are connected to the HeartStart MRx. If the parameter source is the configured choice of a particular wave sector, it is displayed in that wave sector. If you connect a parameter source that is not configured to be displayed, it is displayed in the first empty wave sector. If you subsequently connect the configured parameter source, it replaces the current parameter. For invasive pressures, you should label your waveforms as they are connected to avoid possible confusion.

## Changing Displayed Waveforms

Wave Sector 1 has a dedicated Lead Select button to change the displayed lead/source. Waveforms displayed in other wave sectors may be changed for the current patient through the menu. See “Menus” on page 19.

## Parameter Blocks

Measurements for monitored parameters are provided in the parameter blocks. Parameter Block 1 always contains the heart rate and HR alarm settings. The position of the other parameters are in fixed locations depending upon the options which were included in your HeartStart MRx. Each measurement is labeled and displays the current value and the high and low alarm limit settings or the  (alarms off) icon. A “-?-” is displayed until a valid measurement can be obtained.

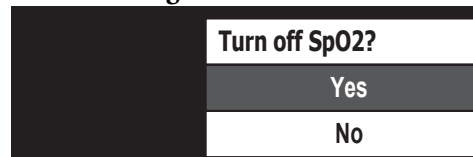
Your parameter text colors will always match their corresponding wave.


Parameter Alarm Messages are displayed in the space above each numeric value, replacing the parameter label, except HR.

## Turning Parameters On/Off

SpO<sub>2</sub>, Invasive Pressures, EtCO<sub>2</sub> and Temperature parameters are activated when the associated parameter cable/tubing is connected. To turn the parameter off, disconnect the cable/tubing from the HeartStart MRx. A prompt message (see Figure 8) alerts you that the parameter has been disconnected and requests confirmation to turn the parameter off.

**Figure 8 Parameter Message**






Press the Menu Select  button to select **Yes**, confirm your action and turn off the parameter. If you do not wish to turn the parameter off, use the Navigation Buttons to highlight **No**. Press the Menu Select button to keep the parameter on and reconnect the cable/tubing. You can also ignore the message and reconnect the cable/tubing. The HeartStart MRx will detect the connection and remove the message.

## Soft Key Labels

The four soft key labels correspond to the soft key buttons located immediately below. These labels change, as appropriate, according to the current display view and function. Soft key labels appearing as gray text indicate that the soft key is inactive.

## Menus

Menus with controls and options specific to each function of the HeartStart MRx are easily accessible using the Menu Select and Navigation buttons located on the front panel. Menus are used to adjust volume, select waveforms for display, select waves for printed strips, set alarms, schedule measurements, enter patient information, perform the Operational Check, generate reports, and a variety of other tasks. Menus and submenus are organized to allow you to conveniently make selections and enter information.

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. Select **Exit** to close the menu without activating a selection.

**Figure 9 Sample Menu**

<b>HR/Arrhythmia</b>
<b>Relearn Rhythm</b>
<b>Alarms Off</b>
<b>HR Limits</b>
<b>VTACH Limits</b>
<b>Exit</b>


## Message Windows

Periodically, message windows appear on the display to provide additional status information, alert you to an error or a potential problem, or direct you to take action. Remain alert to these messages. If a response is required, use the Navigation and Menu buttons to highlight and select the appropriate answer.

**Figure 10 Sample Message Window**

<b>Connect Pads Cable</b>
---------------------------

## High Contrast Display

To optimize visibility of the HeartStart MRx display when used in bright sunlight, the device provides a High Contrast feature which may be enabled. In this view, the MRx display appears using a yellow background with all other screen elements appearing in black or shades of gray. High Contrast is enabled in Manual Defib, Pacer and Monitor Modes by pressing the Menu Select  button and selecting **High Contrast On** from the Main Menu.

**NOTE** The High Contrast feature does not display colors configured as red or blue, therefore, be sure your device is configured correctly with the appropriate parameter color settings. Refer to “Configuration” on page 181 for more information.

## Controls

The Therapy Knob is used to turn the HeartStart MRx on in the desired mode of operation. Operating controls are organized by function, with general function buttons located along the left and bottom sides of the display, defibrillation controls to the right of the display, and soft keys immediately below the display. (See Figure 1.)

### Therapy Knob

The Therapy Knob serves as the power switch for the HeartStart MRx. It can be set to:


- **Off**
- **AED** - to enable AED Mode for semi-automated external defibrillation.
- **Monitor** - to enable Monitor Mode for 3- or 5-lead ECG monitoring, 12-lead ECG acquisition (optional), Vital Signs Trending, or monitoring of optional parameters.
- **Pacer** - to enable Pacer Mode (optional) for demand or fixed mode pacing.
- **Manual Defib** - to enable Manual Defib Mode for asynchronous or synchronous defibrillation (cardioversion) at the selected energy setting.


In Manual Defib Mode, without Pacing, the defibrillation energy settings are labeled as 1-9, 10, 15, 20, 30, 50, 70, 100, 120, 150, 170, and 200 Joules. If your unit is equipped with Pacing, the energy settings are labeled as 1-10, 15, 20, 30, 50, 70, 100, 120, 150, 170, and 200 Joules.





## General Function Buttons

The general function buttons control monitoring or non-critical resuscitation activities. They include:

**Mark Event button**  - allows you to insert a time-stamped annotation in the Event Summary Report to note events as they occur, including the administration of certain drugs. A Mark Event button label appears at the top left corner of the display.


**Lead Select button**  - changes the ECG lead in Wave Sector 1. Pressing this button cycles through the available ECG waves, changing the displayed wave and label. The list of available ECG waves is based on the current lead set and device configuration, and includes pads or paddles, if the corresponding cable is connected to the device.

**Alarm Pause button**  - The Alarm Pause button pauses all visual and audible physiological alarms and audible inops for the configured time interval. At the end of the pause interval, each alarm returns to its previous setting (On or Off). Pressing the Alarm Pause button during the pause interval also returns alarms to their previous settings.

**Print button**  - The Print button initiates a continuous print-out of the primary ECG and other selected waveform(s) either real-time or with a 10-second delay, depending on your configuration.

**Summary button**  - The Summary button displays a menu from which you can print the current or most recent Event Summary report or Vital Signs Trending Report.

**Menu Select button**  - Pressing the Menu Select button either brings up the current menu or confirms a menu selection.

**Navigation buttons**  - The Navigation buttons display the current menu just as the Menu Select button does. Additionally, within any menu or list, these buttons move to the next or previous item in the list. They also increase or decrease numbers or values in a sequence.

## Defibrillation Controls

The defibrillation controls are shown in Figure 11. They include:

**Therapy Knob** - Enables AED or selects an energy for Manual Defib Mode defibrillation or cardioversion.

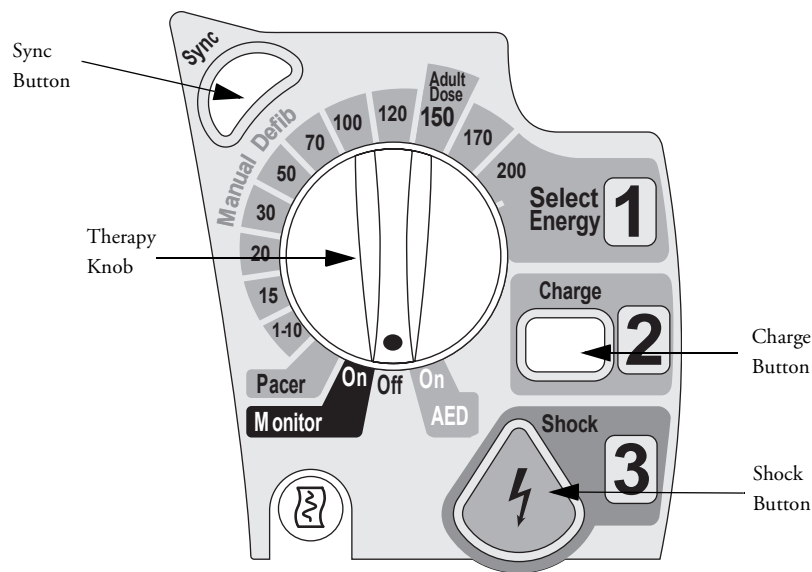
**Charge Button** - Charges the defibrillator to the selected Manual Defib energy setting. Used only in Manual Defib Mode. In AED Mode, the defibrillator charges automatically.

**Shock Button** - Delivers a shock through multifunction electrode pads or switchless internal paddles. In AED mode a 150J shock is delivered. In Manual Defib Mode, the shock is delivered at the selected Manual Defib energy setting.

**NOTE** When external paddles or switched internal paddles are used, once the HeartStart MRx is fully charged, the shock is delivered by pressing the Shock button(s) on the paddles.

**Sync Button** - Toggles between synchronized energy delivery used during cardioversion and asynchronous energy delivery used during defibrillation.

**Figure 11 Defibrillation Controls**







## Soft Keys

The soft keys perform the function displayed as a label appearing immediately above on the display. The labels (and, therefore, the function) change appropriately for the various modes of operation and are described in the following chapters.

## Indicators

The HeartStart MRx indicators provide a visual display of device status.

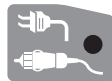
**Ready For Use Indicator** The Ready For Use (RFU) indicator is located on the upper, right corner of the device. It indicates the status of the therapy delivery functions of the monitor/defibrillator using the following definitions:

- A blinking black hourglass symbol  indicates the shock, pacing, and ECG functions of the device are ready for use. Sufficient battery power is available for device operation. Additionally, a blinking black hourglass, together with the presence of external power (AC or DC), indicates that installed battery(s) are being charged.
- A blinking red "X"  and a periodic audio chirp indicate no battery is present or a low battery condition. The device can be used, but its operation time is limited. If a battery is inserted and charging, the audio chirp is not present.
- A solid red "X"  and a periodic audio chirp indicate a failure has been detected that may prevent the delivery of defibrillation therapy, pacing, or ECG acquisition. When turned on, the device displays INOP messages for the failures detected.
- A solid red "X"  without periodic audio chirps indicates either there is no power available, or the device cannot power on. If, after power is supplied, the indicator reverts to the blinking black hourglass symbol, the device is once again ready for use.

**NOTE** The RFU indicator may briefly display a solid red "X" when initially turning the device on, when switching between clinical and non-clinical operating modes, and at the start of any automated test. This does not indicate a failure of the device.

**External Power Indicator** The external power indicator is located above the display. It is green if power is being provided by an external AC or DC power source. See Figure 12.

**Figure 12 External Power Indicator**



**NOTE** The external power indicator will momentarily go out when charging for defibrillation with a charged battery installed. This is normal operation, as the device is switching its power source to the battery for a faster charge time.



**NOTE** The AC Line Filter default setting of all HeartStart MRx devices is 60 Hz. You should adjust the AC Line Filter default to the electric power frequency of your country. See "Configurable Parameters" on page 184.

# Audio Recording

If your device has the Audio Recording option, it is configured to “On” by default and cannot be turned off during use, but can be turned off in Configuration Mode.

One of the following icons is displayed to the left of the battery icon in all clinical modes:

**Table 2 Audio Recording Icon**

Symbol	Definition
	Audio recording on.
	Audio recording off.

Audio is not recorded if any of the following circumstances occur:

- The Audio Recording configuration setting is set to Off
- The HeartStart MRx is in Monitor, 12-Lead, or Pacer mode
- 90 minutes of audio has been recorded for the current event

## Reviewing Recorded Audio

To review the recorded audio:

- Copy the event data from the HeartStart MRx internal memory to an external data card. See the “Data Management” chapter on page 203 for information.
- Import the data into the Q-CPR Review application. See the *Q-CPR Review Directions for Use* for more information.

# Alarms

The HeartStart MRx provides various alarm types indicating changes in patient condition or device/cable conditions which may require attention. Table 3 details different alarm types.

**Table 3 HeartStart MRx Alarm Types**

Type of Alarm	Condition
Red	High priority. Life-threatening alarm condition is present. Immediate operator response is required. Red alarm message; alarm tone.
Yellow	Medium priority. Non life-threatening alarm condition is present. Prompt operator response is required. Yellow alarm message; alarm tone.
INOP	Low priority. Most technical alarms are grouped together as INOPs and are handled as low priority alarms indicating a problematic condition exists related to the ability of part or all of the device to perform its intended monitoring function. Operator awareness is required. Exception: conditions which stop or may stop the delivery of pacing therapy and invasive pressure disconnect. These are classified as high priority technical alerts. They are potentially life-threatening conditions.
Latching	Alarm is announced and remains present regardless of whether the alarm condition continues to exist. A latching alarm is not removed until it is either acknowledged or a higher priority alarm condition occurs.
Non-latching	Alarm is automatically removed when the alarm condition no longer exists.

**NOTE** The presence of multiple alarm conditions is quite possible. Announcing all of the detected alarms would cause confusion and a less serious condition might hide a more serious condition. For this reason, alarms are prioritized and categorized so that the most serious or highest priority alarm condition is the one announced. If multiple same-parameter, same-priority alarms occur, all alarms will be displayed.

**NOTE** Audio is suppressed for INOP alarms for the first 60 seconds after the HeartStart MRx is turned on. INOP messages do appear on the display.

## Responding to Alarms

Alarm limits are displayed with each parameter if alarms for the parameter are on. When an alarm condition occurs and an alarm is indicated, visually and audibly, there are several ways to respond. Initially:

- 1 Attend to the patient.
- 2 Identify the alarm(s) indicated.
- 3 Silence the alarm(s). When a physiological alarm is announced, the audio pause label (see Figure 13) is displayed above the Navigation and Menu Select buttons. Pressing any of these buttons will silence the audio for all active alarms while you are attending to the patient. If the alarming condition continues to exist, it will re-alarm in two minutes. Silencing a specific alarm does not prevent another alarm condition from sounding. If you also silence the second alarm, it resets the two-minute audio pause for all active alarms.

When an INOP is announced without a concurrent physiological alarm, the audio off label is displayed above the Navigation and Menu Select buttons. Pressing any of these buttons will silence

the audio for all active alarms while you are attending to the patient. INOPs do not reannunciate after pressing audio off.

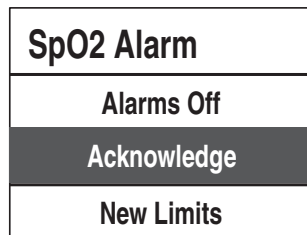
**Figure 13 Audio Pause Label**




Then:

- 4 Address the alarm condition on the HeartStart MRx. The menu shown in Figure 14 appears.

**Figure 14 Sample Alarm Response Menu**



**Alarms Off** Turns the monitoring parameter's alarms off and prevents future parameter alarms from alarming. The alarm message is no longer displayed, and the  icon appears next to the parameter value.

**Acknowledge** For latching alarms, acknowledge clears the alarm condition when the condition no longer exists.

**New Limits** Adjust the parameter alarm limits accordingly.

**NOTE** Alarm history can be accessed in the patient's Event Summary. This information is maintained after powering the device down and in the unlikely event of power loss.

---

**WARNING** Although the Alarm Pause button can be used when responding to alarms, the response procedures described above are recommended. Alarm Pause removes audio and visual indications of active alarm conditions as well as inhibiting indications of new alarm conditions.

A potential hazard exists if different alarm limits are used for the same or similar equipment in any single area.

Confirm the alarm limits are appropriate for the patient each time there is a new patient incident.

Do not set alarm limits to such extreme values that render the alarm system useless.

---

**NOTE** Heart Rate or Arrhythmia Alarms function a bit differently than other alarms. For information about responding to these alarms, see "Responding to HR and Arrhythmia Alarms" on page 59.

# Entering Patient Information

Patient information may be entered for the following:

- Name
- ID
- Patient Category
- Age
- Sex
- Paced (internal paced status)

Information is entered using the **Patient Info** menu. Patient Name is entered using 2 alphabetical lists, one to enter the last name, followed by another to enter the first name. When each name is complete, select **Done**. Select **Cancel** to close the patient name menu without saving.

## Continued Use

Once a patient incident begins, the Continued Use feature is activated. This feature facilitates continued treatment of the same patient by retaining the current settings and the patient record when the HeartStart MRx is turned off for less than 10 seconds, for instance when switching between AED and Manual Defib Modes or when the Therapy Knob is inadvertently moved to **Off**. When turned on within the 10-second time period, the HeartStart MRx retains the most recent settings, including:

- Alarm settings
- Wave Sector settings
- Event Timer
- QRS, alarm tone, and voice prompt volumes
- ECG gain
- Vital Signs Trending data
- Pacing settings (The device DOES NOT automatically resume pacing.)
- Patient record in the Event Summary Report; new data is appended to the record.


The Sync feature remains active if the HeartStart MRx is turned off for less than 10 seconds. However, Sync is disabled when AED Mode is activated, and must be turned on upon returning to Manual Defib Mode.

**NOTE** The Continued Use feature will not function if all sources of power (battery and external AC/DC power modules) are removed from the device, even briefly.


# Printing Waveforms

By using the Print Button on the front of the HeartStart MRx, you can obtain a continuous printout of the primary ECG and one additional waveform if you have the 50mm printer installed; two additional waveforms if you have the 75mm printer installed. Certain waveforms (including invasive pressures and CO<sub>2</sub>) will include scale indications on the printout. The printouts are generated either real-time or with a 10-second delay, depending on your configuration.

For devices with a 50mm printer, to change wave forms for the second wave printed, perform the steps below:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Printed Waves** option and press the Menu Select button.
- 3 Using the Navigation buttons, select the wave form you want to print in Wave 2 and press the Menu Select button.

For devices with a 75mm printer, to change wave forms for the second or third waves printed, perform the steps below:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Printed Waves** option and press the Menu Select button.
- 3 Using the Navigation buttons, select **Wave 2** or **Wave 3** and press the Menu Select button.
- 4 Using the Navigation buttons, select the wave form you want printed and press the Menu Select button.
- 5 Repeat Steps 2 through 4 for the other printed wave.




## Return to Owner

The Return to Owner feature allows the owner of the HeartStart MRx to enable a specified loan period. When the time period is up, the borrower of the HeartStart MRx will be reminded to return the device to its owner as identified on the display. The feature is password protected in Configuration and enabled through the **Other** Menu, where the owner can activate, deactivate, and specify the length of the loan period.


**NOTE** Monitoring and defibrillation functions are suspended while the Return to Owner set-up screen is displayed. Alarms Off is indicated on the display. Monitoring and defibrillation functions will return when exiting the Return to Owner screen.

**NOTE** The appearance of the loan expiration message does not disable monitoring and defibrillation functionality.

To enable the Return to Owner feature:

- 1 Press the Menu Select  button.
- 2 Select **Other** from the menu and press the Menu Select button.
- 3 Select **Return To Owner** and press the Menu Select button.
- 4 Press the [**Activate**] soft key.
- 5 Enter the number of days in the loan period and press the Menu Select button.
- 6 Press the [**Exit Return-To**] soft key.

To disable the Return to Owner feature:

- 1 Press the Menu Select  button.
- 2 Select **Other** from the menu and press the Menu Select button.
- 3 Select **Return To Owner** and press the Menu Select button.
- 4 Press the [**Deactivate**] soft key.
- 5 Enter the password and press the Menu Select button.
- 6 Press the [**Exit Return-To**] soft key.



---

# Setting Up

This chapter provides the basic set-up information you need to prepare your HeartStart MRx for operation and to connect the optional monitoring accessories.

**NOTE** If your HeartStart MRx does not have some of the optional functionality or accessory pouches listed in this chapter, disregard these features and related information.

Before using the HeartStart MRx, review the configuration settings of your device. Confirm and update the settings as appropriate.

## Attaching the Carrying Case and Accessory Pouches

The HeartStart MRx accessory pouches are designed to hold your essential monitoring and defibrillation accessories. Follow the procedures below for assembly and recommended accessory placement.

- 1 Disconnect all external power and remove all batteries.
- 2 Lower the device into the sleeve of the carry case. The rear base of the device fits in the sleeve socket.

### Paddle Tray

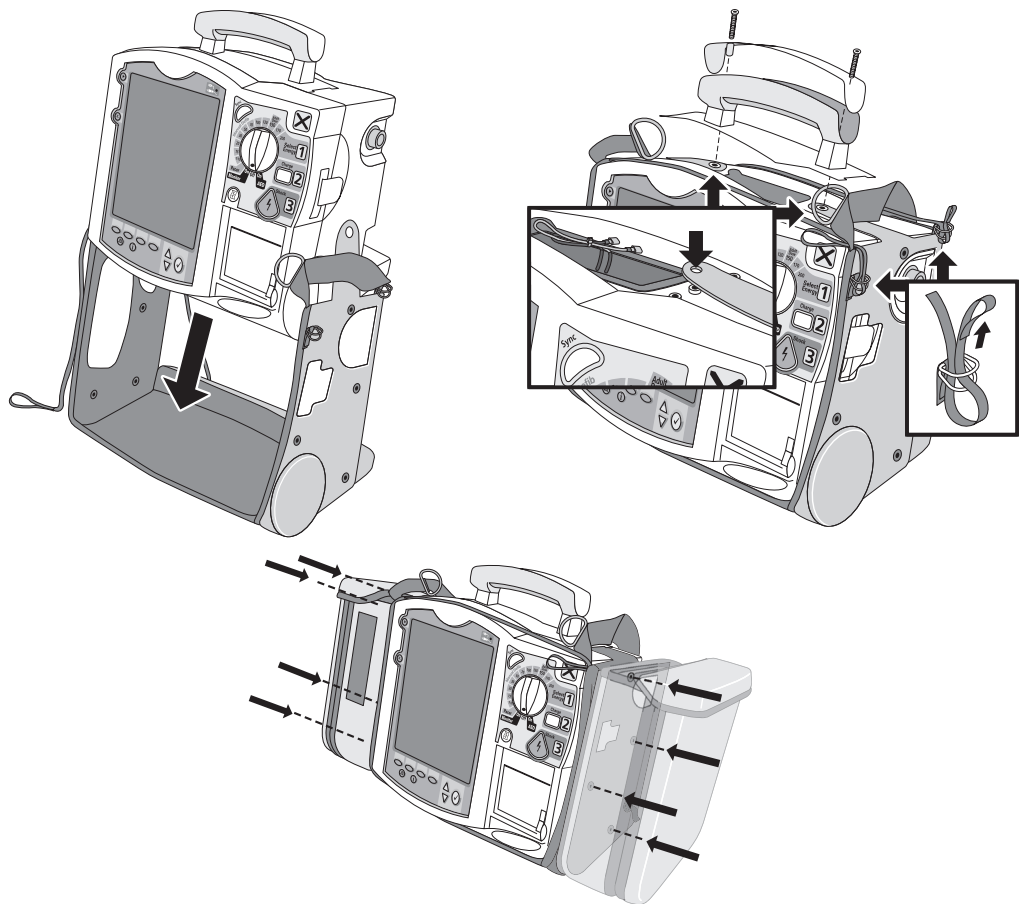
- a. If paddles are connected, disconnect them from the Therapy port and remove them from the paddle tray.
- b. Remove the 4 T-15 screws from the tray plates.
- c. Gently lift the paddle tray up, leaving all wires connected.

### Handle Only

- a. Remove the handle cover by pushing in on either side of the handle cover and lifting up or by lifting the corners of the label to expose the two T-15 screws.
- b. Remove the 2 T-15 screws.
- c. Remove the handle.
- d. Gently lift the cap plate up.

- 3 Fold the two sleeve flaps over the top of the device, positioning them so that the screw holes are exposed.
- 4 Replace the paddle tray or cap plate, as appropriate, so that the molded openings fit over the sleeve flaps.
- 5 Replace the handle.
- 6 If your handle cover does not have screw holes, insert the 2 T-15 screws and tighten. Then snap the handle cover in place by pushing down on either side of the handle cover.
- 7 If your handle cover has screw holes, replace the handle cover and then insert the 2 T-15 screws and tighten. Smooth down the label corners to cover the screw holes.
- 8 Secure the front and rear cinch straps using the metal rings provided.
- 9 Perform an Operational Check as described in, "Operational Check" on page 222.
- 10 Attach the side pouches using the snaps located inside the pouch pockets or, if equipped, use the hook and loop fastener with the flaps and slots.

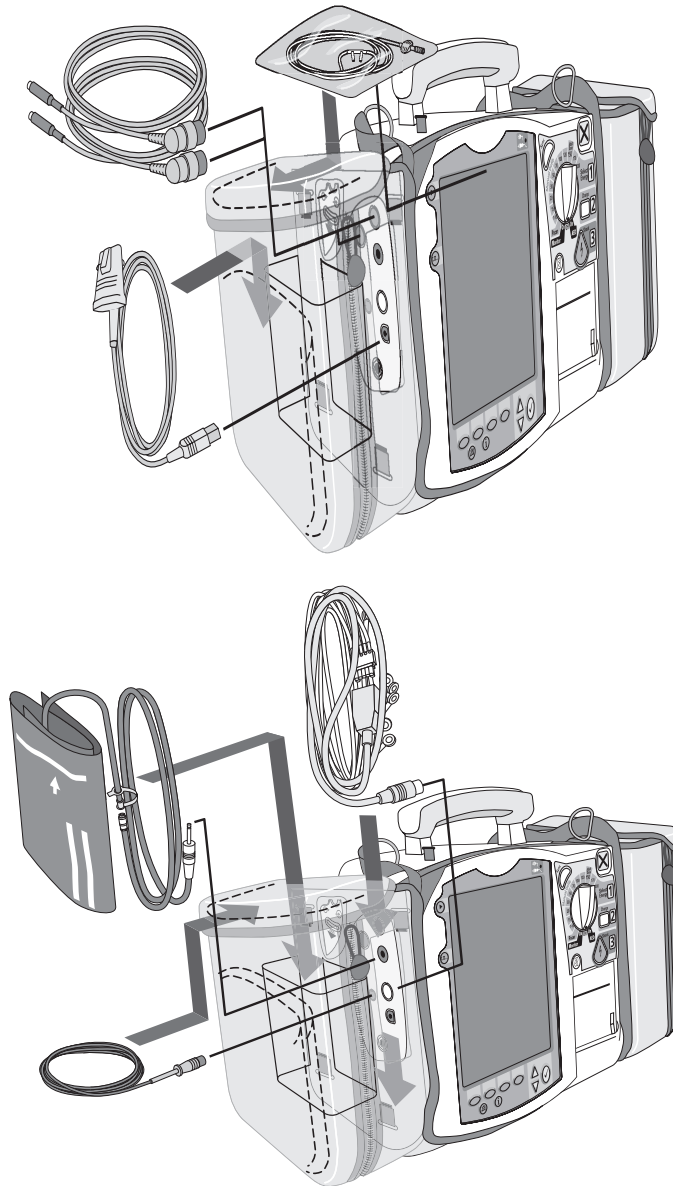
**Figure 15 Accessory Pouch Assembly**



# Storing Accessories

Suggested parameter cabling and accessories storage is shown below.

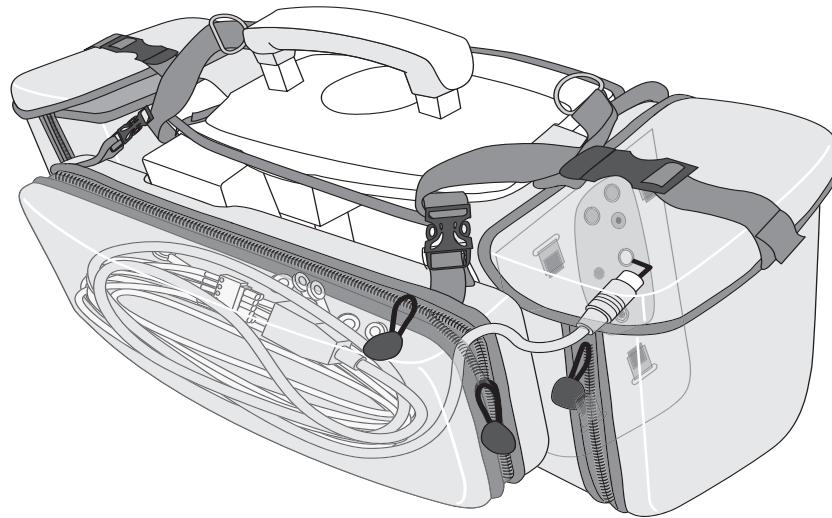
Figure 16 Storing Accessories



- 1 Attach the Therapy cable and route it through cable fastener loop, securing the cable just below the strain relief.
- 2 Attach the rear pouch using the buckles provided.

**NOTE** Depressions are provided on the inside of the rear pouch should you wish to make a cut-out to accommodate external power. Some devices may come with the cut-outs already made.

**Figure 17 Connecting Cables**



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**WARNING** When using the carry bag to transport the HeartStart MRx, it is important to position it with the display facing away from the body. If not, the Therapy Knob may be bumped and inadvertently moved from its current position.

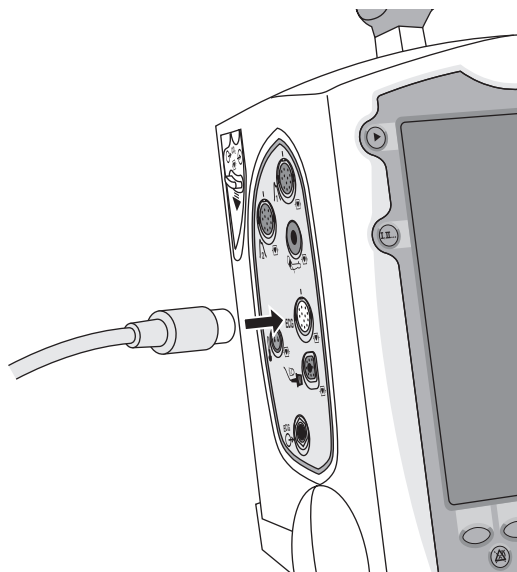
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## Connecting the ECG Cable

To connect a 3-, 5- or 10-lead cable:

- 1 Align the ECG cable with the white ECG port, as shown in Figure 18. The white key marker on the ECG cable faces the top of the device.
- 2 Push the ECG cable firmly into the ECG port, until the white portion of the cable connector is no longer visible.

**Figure 18** Connecting the ECG Patient Cable





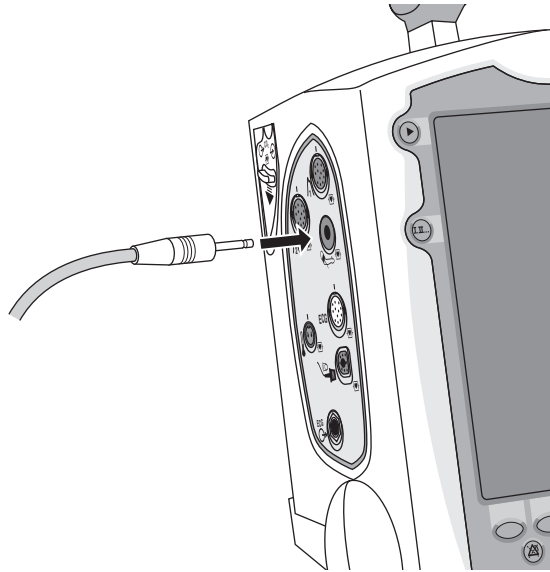


## Connecting the NBP Interconnect Tubing

To connect the NBP Interconnect Tubing:

- 1 Insert the NBP Interconnect Tubing into the red NBP port as shown in Figure 20.
- 2 Attach the NBP Interconnect Tubing fitting to the NBP cuff.

**Figure 20** Connecting NBP Interconnect Tubing / NBP Cuff

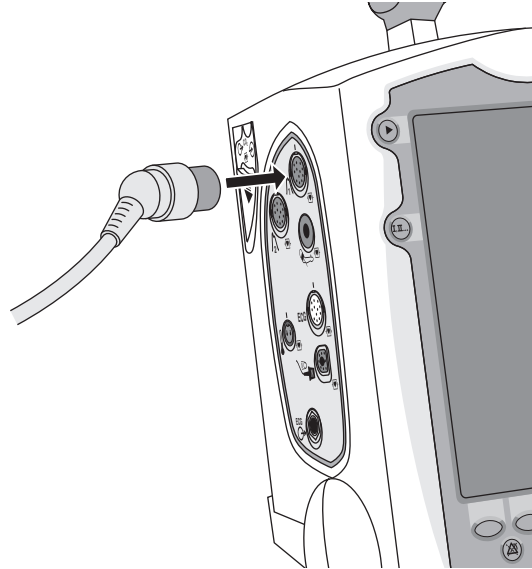


## Connecting the Invasive Pressures Cable

To connect the invasive pressure cable:

- 1 Insert the invasive pressure cable into either of the invasive pressure ports as shown in Figure 21.
- 2 Attach the invasive pressure cable to your transducer/tubing.
- 3 Assign a label to the connection on the HeartStart MRx.

**Figure 21** Connecting Invasive Pressure Cable

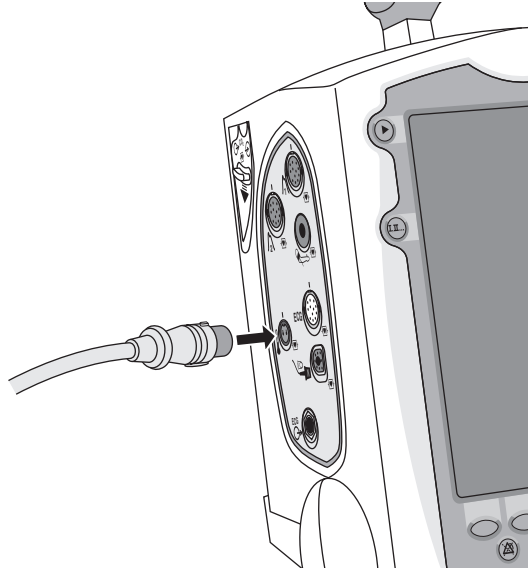


## Connecting the Temperature Cable

To connect the temperature cable:

- 1 Insert the temperature cable into the temperature port as shown in Figure 22.
- 2 If needed, attach the cable to your probe.

**Figure 22** Connecting the Temperature Cable

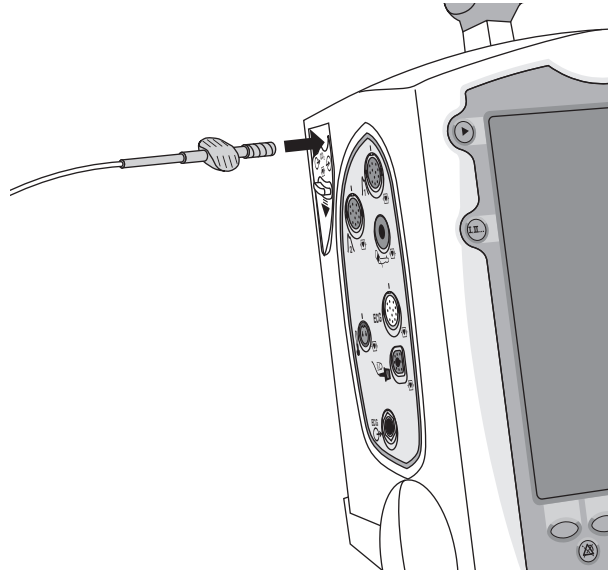


## Connecting the CO<sub>2</sub> FilterLine

To connect the CO<sub>2</sub> FilterLine<sup>®</sup>:

- 1 Using the end of the FilterLine fitting, slide the CO<sub>2</sub> compartment door down.
- 2 Insert the fitting into the CO<sub>2</sub> Inlet port as shown in Figure 23.
- 3 Turn the fitting clockwise into place.

**Figure 23** Connecting the CO<sub>2</sub> FilterLine

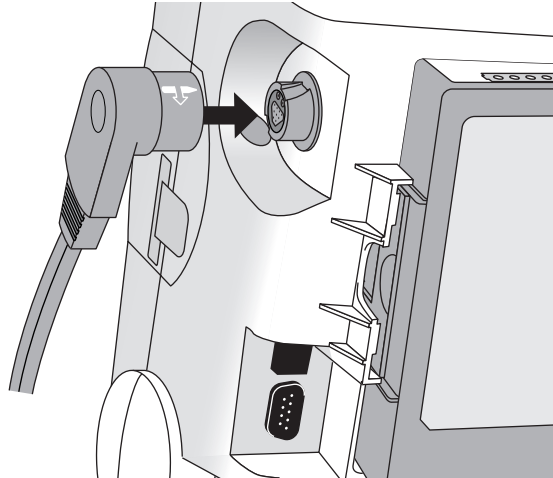


## Connecting the Therapy or Pads/CPR cables

To connect the Therapy or Pads/CPR cable:

- 1 Align the white pointer on the cable with the white arrow on the green Therapy port as shown in Figure 24.
- 2 Insert the cable into the green Therapy port. Push until you hear it click into place.

**Figure 24** Connecting the Therapy or Pads/CPR Cable



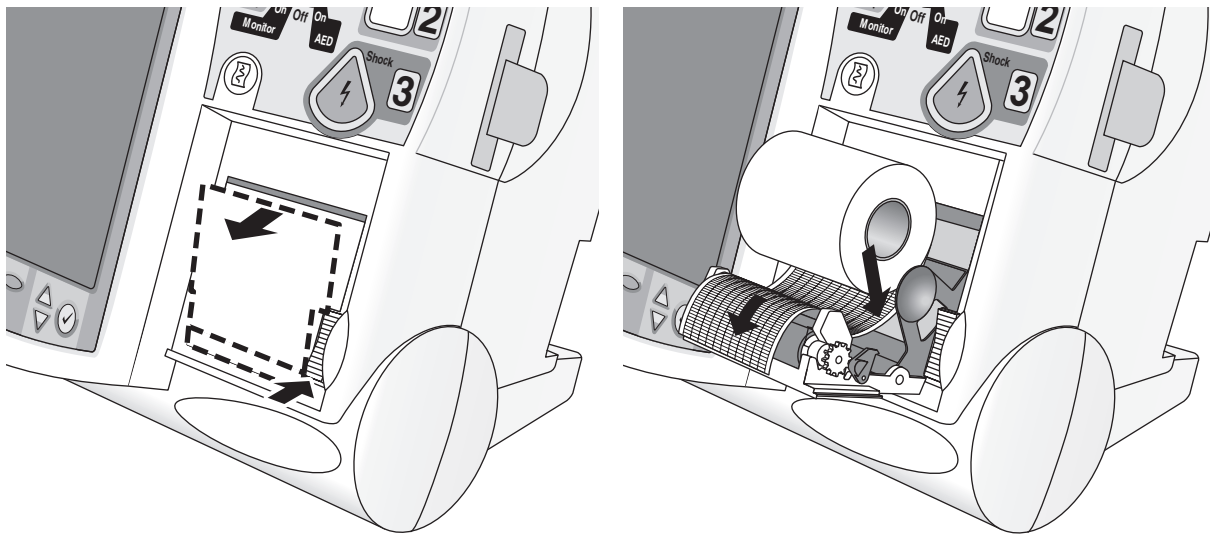
# Installing Paper

## 50mm Printer

To install printer paper:

- 1 Open the printer door by pushing on the latch as shown in Figure 25.
- 2 If there is an empty or low paper roll in the printer, pull up on the roll to remove it.
- 3 Place a new roll of printer paper into the paper well, positioning the roll so that the end of the roll is on the bottom and the grid faces up.
- 4 Pull the end of the paper out past the paper roller.
- 5 Close the printer door.

**Figure 25 Installing Paper (50mm)**

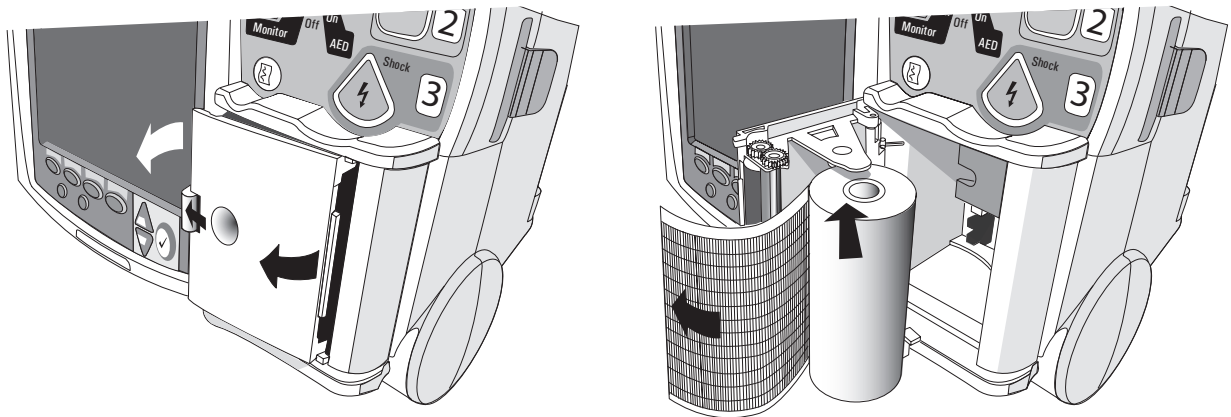


## 75mm Printer (optional)

To install printer paper:

- 1 Open the printer door by pushing on the latch as shown in Figure 26.
- 2 If there is an empty or low paper roll in the printer, pull up on the tab holding the paper roll to remove it.
- 3 Place a new roll of printer paper into the paper well, positioning the roll as shown in Figure 26.
- 4 Pull the end of the paper out past the paper roller.
- 5 Close the printer door.

**Figure 26** Installing Paper (75mm)

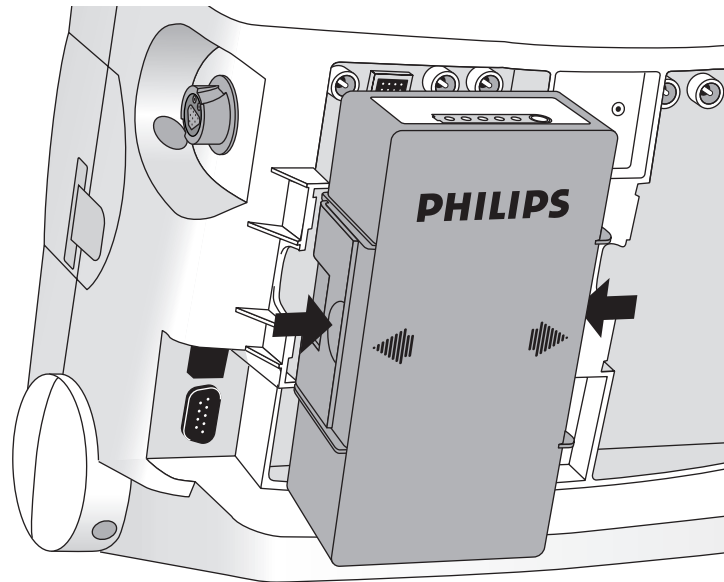


## Installing Batteries

To install the batteries:

- 1 Align the M3538A Lithium Ion battery in a battery compartment.
- 2 Insert the battery, and press until you hear it click into place. Ensure that the latches located on both sides of the battery are engaged fully.

**Figure 27** Installing Batteries



## Charging Batteries

Charge batteries fully upon receipt and prior to use. Be sure to familiarize yourself with the battery maintenance procedures discussed in “Battery Maintenance” on page 235.

## Battery Safety

Review the Application Note, *M3538A Lithium Ion Battery - Characteristics and Care*, provided with your HeartStart MRx. Additionally, read the battery related warnings in “Specifications and Safety” on page 273, prior to using the M3538A Lithium Ion Battery.

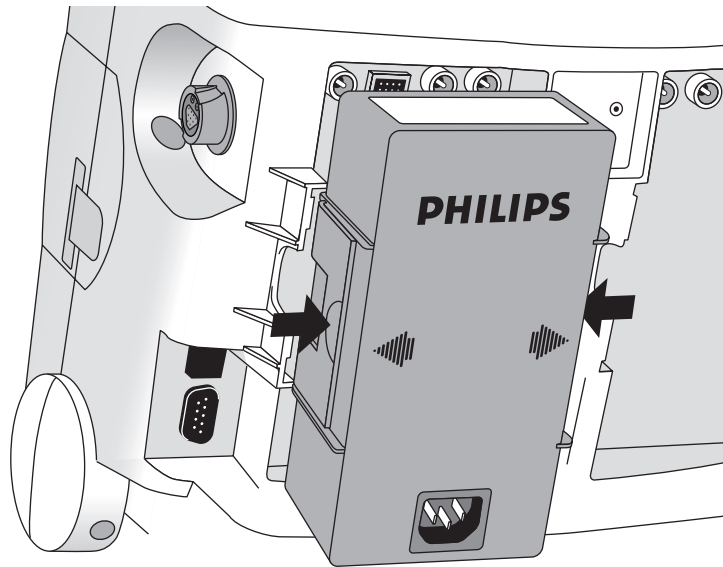


## Installing the AC Power Module

If not presently installed in your device, insert the M3539A AC power module as follows:

- 1 Align the M3539A AC power module in Compartment B.
- 2 Insert the AC power module, and press until you hear it click into place. Ensure that the latched located on both sides of the AC power module are engaged fully.
- 3 Insert the power cord into the AC power receptacle.
- 4 Plug into an AC power outlet.
- 5 Check that the External Power indicator on the front panel is illuminated.

**Figure 28** Installing the AC Power Module

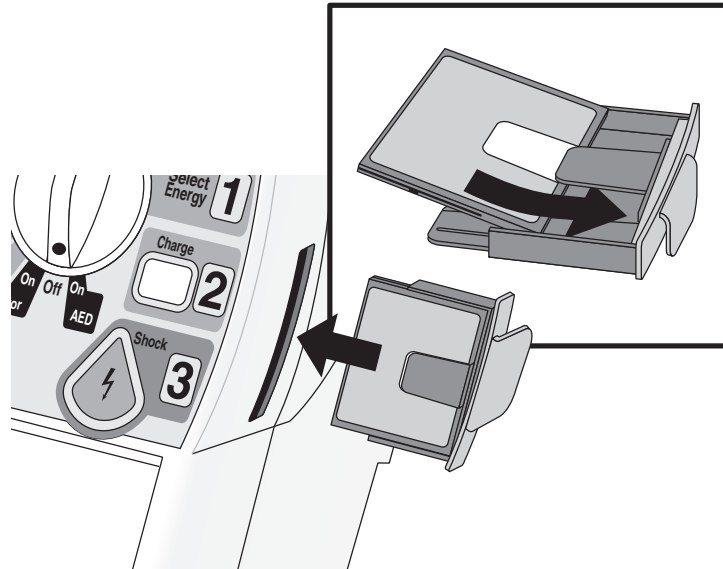


## Installing the Data Card

If not presently installed in your device, install the data card as follows:

- 1 Insert the data card in the data card tray, sliding it under the tray clip.
- 2 With the front of the tray facing forward, insert the tray fully into the data card slot located on the right side of the HeartStart MRx.

**Figure 29** Installing the Data Card/Tray



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**CAUTION** Even if a data card is not used, the data card tray should always be installed to protect the device from the ingress of liquids or solids.

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# ECG and Arrhythmia Monitoring

This chapter describes the basic ECG and arrhythmia monitoring functions of the HeartStart MRx monitor/defibrillator. For specific information related to taking a 12-Lead ECG, refer to Chapter 13, “12-Lead ECG” on page 137.

## Overview

The HeartStart MRx can be used for ECG and arrhythmia monitoring, allowing you to monitor through:

- multifunction electrode pads, or
- 3-, 5-, or 10-lead monitoring electrode ECG sets.

If both pads and monitoring electrodes are connected, monitoring allows you to select a lead from the 3-, 5- or 10-lead monitoring electrode ECG source, or to monitor through pads.

Configurable heart rate and arrhythmia alarms clearly communicate patient status, both audibly and visually.

Waveforms may be acquired through the therapy port for pads/paddles or the monitoring port for 3-, 5-, or 10-lead monitoring electrodes. If the configured source is not connected to the HeartStart MRx when turned on, the first valid ECG source is displayed in Wave Sector 1. Once the configured source is available, it automatically populates Wave Sector 1. Should the configured source then become invalid, a Leads Off condition is displayed. The HeartStart MRx *does not* revert to the initial source of ECG but you can select a lead by pressing the Lead Select button.

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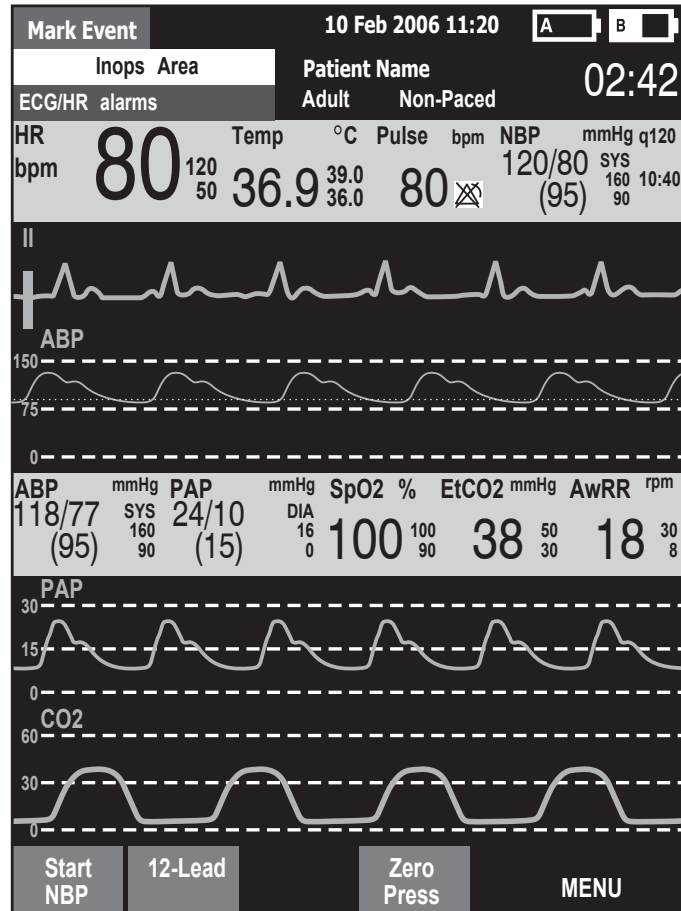
**WARNING** Do not use the HeartStart MRx to monitor neonatal ECGs. Doing so could result in inaccurate measurements and alarms.

---

# Monitoring View

Monitoring View appears on the display when the Therapy Knob is in the **Monitor** position. Figure 30 shows the information displayed in Monitoring View.

**Figure 30 Monitoring View**



Monitoring View can display up to four ECG waves. Numeric values for heart rate and all other available parameters are displayed, as well as any active alarm settings.

There are two separate sources of ECG, the ECG leads connection and the Pads/Paddles connection. Leads/pads are displayed according to your device's configuration. Lead II is configured as the primary ECG lead source and is displayed in Wave Sector 1. You may change this during use with the Lead Select button. You can also configure the HeartStart MRx to display up to 3 additional leads (or pads/paddles) when turned on (see "Configuration" on page 181). The leads displayed may be changed during use through the **Displayed Waves** menu item.

Monitoring View displays the first valid source of ECG acquired in Wave Sector 1. For example, if your HeartStart MRx has Lead II configured to display in Wave Sector 1, but pads are attached to the patient and connected to the defibrillator before a valid ECG can be obtained from the monitoring electrodes, then Pads will be displayed in Wave Sector 1. However, Lead II will take its place as soon as it is acquired.

**NOTE** The ECG lead source appearing in Wave Sector 1 is used to determine heart rate and monitor arrhythmia.

## Preparing to Monitor ECG

To prepare for monitoring ECG, perform the following steps.

If monitoring via electrodes:

- 1 Prepare the patient's skin prior to applying monitoring electrodes. Skin is a poor conductor of electricity, so skin preparation is important in achieving good electrode-to-skin contact.
  - Identify the appropriate electrode sites (See Figures 32 and 33.)
  - If necessary, clip hair at the electrode sites (or shave sites if needed).
  - Clean and abrade the skin at the electrode site.
  - Dry the electrode sites briskly to increase capillary blood flow in the tissues and to remove oil and skin cells.
- 2 Attach the snaps to the electrodes before placing them on the patient.
- 3 Apply the electrodes by peeling them, one at a time, from the protective backing and sticking them firmly to the patient's skin. Refer to Figures 32 and 33 for proper electrode placement. Press around the entire edge of each electrode to ensure they are secure. Make sure the lead wires do not pull on the electrodes.

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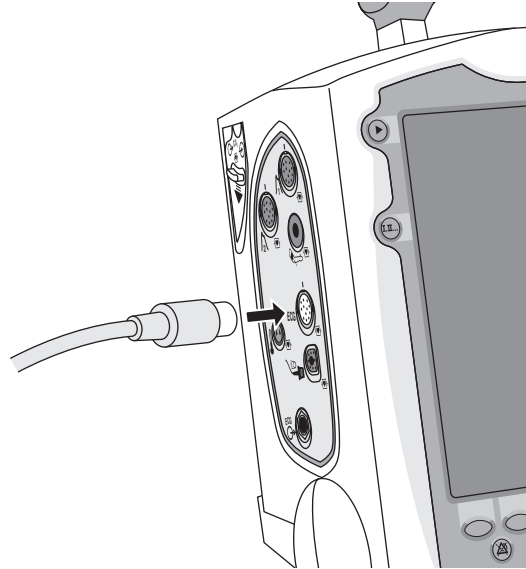
**WARNING** Be sure that the electrodes do not come in contact with other conductive materials, especially when connecting or disconnecting the electrodes to/from the patient.

---

**NOTE** A signal from a TENS unit can cause ECG artifact.

- 4 If not preconnected, connect the ECG patient cable.
  - Align the keyed patient cable connector with the ECG port on the Measurement module, as shown in Figure 31.
  - Push the patient cable firmly into the ECG port until the white portion is no longer visible.

**Figure 31 ECG Cable Connection**



**If monitoring via multifunction electrode pads:**

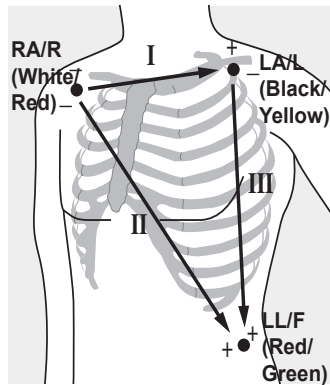
- 1 If not preconnected, connect the pads cable to the HeartStart MRx. See Figure 40 on page 65.
- 2 Connect the pads to the pads cable. See Figure 41 on page 66.
- 3 Apply the pads as directed on the package.

**NOTE** If monitoring for extended periods of time, monitoring electrodes and multifunction electrode pads may need to be changed periodically. Refer to the manufacturer's documentation for how often to replace the monitoring electrodes or pads.

## Electrode Placement

Figure 32 shows the typical electrode placement for a 3-lead ECG set.

**Figure 32 3-lead Placement**



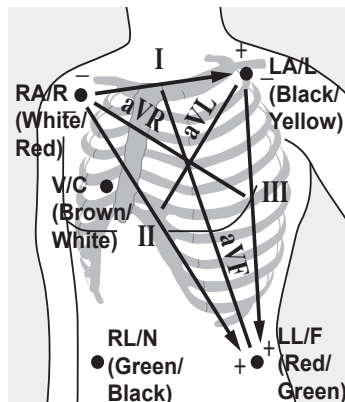
**RA/R placement:** directly below the clavicle and near the right shoulder

**LA/L placement:** directly below the clavicle and near the left shoulder

**LL/F placement:** on the left lower abdomen

Figure 33 shows the typical electrode placement for a 5-lead ECG set.

**Figure 33 5-lead Placement**



**RA/R placement:** directly below the clavicle and near the right shoulder

**LA/L placement:** directly below the clavicle and near the left shoulder

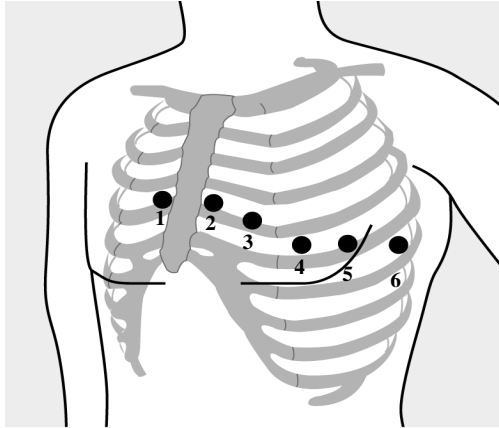
**RL/N placement:** on the right lower abdomen

**LL/F placement:** on the left lower abdomen

**V/C placement:** on the chest; the position depends on your required lead selection. See Figure 34.

The V/C lead may be placed in any of the precordial electrode positions as shown in Figure 34 (V1/C1 through V6/C6).

**Figure 34 V/C Electrode Placement**



**V1/C1 placement:** fourth intercostal space at right sternal margin.

**V2/C2 placement:** fourth intercostal space at left sternal margin.

**V3/C3 placement:** midway between V2 and V4.

**V4/C4 placement:** fifth intercostal space at left midclavicular line.

**V5/C5 placement:** same level as V4 on anterior axillary line.

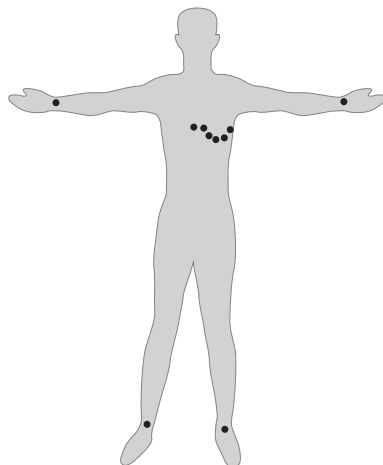
**V6/C6 placement:** same level as V4 at left midaxillary line.

For accurate V/C lead placement and measurement, it is important to locate the fourth intercostal space, as follows:

- 1 Locate the second intercostal space by first palpating the Angle of Lewis (the small bony protuberance where the body of the sternum joins the manubrium). This rise in the sternum is where the second rib is attached, and the space just below this is the second intercostal space.
- 2 Palpate and count down the chest until you locate the fourth intercostal space.

Figure 35 shows the typical electrode placement for a 12-lead ECG set.

**Figure 35 12-lead Placement**



**Conventional 12-Lead ECG** In conventional 12-Lead ECG using 10 electrodes, an electrode is placed on the right arm, left arm, right leg, and left leg. Six V/C electrodes are placed on the chest as shown in Figure 35. The right leg electrode is the reference electrode.

**NOTE** When you do a 12-lead ECG, you should attach the limb leads to the patient's extremities.



## Lead Selection

It is important to select a suitable lead for monitoring so that a QRS complex can be accurately detected. The guidelines for lead selection are as follows:

**For non-paced patients:**

- QRS complex should be tall and narrow (recommended amplitude > 0.5mV).
- R-wave should be above or below the baseline (but not biphasic).
- P-wave should be smaller than 1/5 R-wave height.
- T-wave should be smaller than 1/3 R-wave height.

**NOTE** To prevent detection of P-waves or baseline noises as QRS complexes, the minimum detection level for QRS complexes is set at 0.15 mV, according to AAMI-EC 13 specifications. If the ECG signal is too weak, you may get false alarms for asystole.

**For paced patients with internal/transvenous pacemakers, in addition to the above, the pace pulse should be:**

- not wider than the normal QRS complex.
- large enough to be detected (half the height of the QRS complex), with no re-polarization artifact.

**NOTE** Adjusting the ECG wave size on the display does not affect the ECG signal which is used for arrhythmia analysis.


## Lead Choices


Available monitoring leads vary depending upon what type of ECG cable is connected to your HeartStart MRx and its configuration. Table 4 shows the choice of leads available for 3-, 5-, and 10-lead ECG sets.

**Table 4 Lead Choices**

If you are using:	These leads are available:
a 3-electrode ECG set	I, II, III
a 5-electrode ECG set	I, II, III, aVR, aVL, aVF, V
a 10-electrode ECG set	I, II, III, aVR, aVL, aVF, V1-V6

## Selecting the Lead

The ECG lead for Wave Sector 1 is selected through the Lead Select  button or through the **Displayed Waves** menu. The ECG lead for Wave Sectors 2-4 is selected through the **Displayed Waves** menu, as follows:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Displayed Waves** menu and press the Menu Select button.
- 3 Select the Wave Sector and press the Menu Select button.
- 4 Select the desired lead and press the Menu Select button.
- 5 If needed, use the Navigation buttons to adjust the ECG wave size (gain) and press the Menu Select button.

**Figure 36** Displayed Waves Menu

Main Menu	Displayed Waves	Wave 1	II Size
Volume	Wave 1	Pads	x4
<b>Displayed Waves</b>	Wave 2	I	x2
Printed Waves	Wave 3	<b>II</b>	x1
Measurements/Alarms	Wave 4	III	x1/2
Patient Info	Exit		x1/4
Trends			Auto
Other			
High Contrast On			
Exit			

## Arrhythmia Monitoring

The HeartStart MRx uses the ST/AR Basic Arrhythmia Algorithm. Arrhythmia analysis provides information on your patient's condition, including heart rate and arrhythmia alarms. The HeartStart MRx uses the ECG lead appearing in Wave Sector 1 for single-lead arrhythmia analysis.

**NOTE** Because the ST/AR Basic Arrhythmia Algorithm is the HeartStart MRx's cardiotech source and is needed to generate heart rate and heart rate alarms, the algorithm can never be disabled. However, if desired, arrhythmia and heart rate alarms can be turned off.

During arrhythmia analysis, the monitoring function continuously:

- optimizes ECG signal quality to facilitate arrhythmia analysis. The ECG signal is continuously filtered to remove baseline wander, muscle artifact, and signal irregularities. Also, if the Patient Paced status is set to Yes, pace pulses are filtered out to avoid processing them as QRS beats.
- measures signal features such as R-wave height, width and timing.
- creates beat templates and classifies beats to aid in rhythm analysis and alarm detection.
- examines the ECG signal for ventricular arrhythmias, asystole.

## Aberrantly-Conducted Beats

As P-waves are not analyzed, it is difficult and sometimes impossible for the algorithm to distinguish between an aberrantly-conducted supraventricular beat and a ventricular beat. If the aberrant beat resembles a ventricular beat, it is classified as a ventricular beat. You should always select a lead where the aberrantly-conducted beats have an R-wave that is as narrow as possible to minimize incorrect classifications.

## Intermittent Bundle Branch Block

Bundle branch and other fascicular blocks create a challenge for the arrhythmia algorithm. If the QRS complex changes considerably from the learned normal due to a bundle branch block, the blocked beat may be incorrectly identified as ventricular, and may cause false PVC alarms. You should always select a lead where the bundle branch block beats have an R-wave that is as narrow as possible to minimize incorrect classifications.

**NOTE** For more information on arrhythmia analysis, refer to the Application Note, “Arrhythmia Monitoring Algorithm” available on the web at [www.medical.philips.com/goto/productdocumentation](http://www.medical.philips.com/goto/productdocumentation).

## Heart Rate and Arrhythmia Alarms

The HeartStart MRx detects arrhythmia alarm conditions by comparing ECG data to a set of pre-defined criteria. An alarm can be triggered by a rate exceeding a threshold (for example HR > XX), an abnormal rhythm (for example, Ventricular Tachycardia), or an ectopic event (for example, PVC > limit).

HR/Arrhythmia Alarms can be generated for the conditions shown in Tables 5 and 6. Once generated, they appear as alarm messages in the alarm status area of the display located just above the HR numeric. The notification of an alarm is indicated by both an audible and visual alert signal.

### Arrhythmia Alarm Latching

Arrhythmia alarms are categorized as “latching” or “non-latching” alarms. Latching alarms are announced and remain present, regardless of whether the alarm condition still exists, until they are either acknowledged or a higher priority alarm condition occurs. Indications for non-latching alarms are automatically removed when their alarm condition no longer exists.

Latching and non-latching alarms are categorized in Tables 5 and 6.

**Table 5 HR/Arrhythmia Red Alarms**

Alarm Message	Condition	Indicator	Latching/ Non-Latching
Asystole	No detectable beats for four seconds in the absence of Vfib	Red alarm message, alarm tone	Latching
VFIB/VTACH	A fibrillatory wave detected for four seconds	Red alarm message, alarm tone	Latching
VTACH	Consecutive PVCs and HR exceed configured limits	Red alarm message, alarm tone	Latching
Extreme Brady	10 bpm below HR Low limit, capped at 30 bpm	Red alarm message, alarm tone	Latching
Extreme Tachy	20 bpm above HR High limit capped at 200 bpm (adult) or 240 bpm (pedi)	Red alarm message, alarm tone	Latching

Figure 37 Alarm Chain for Basic Arrhythmia Monitoring

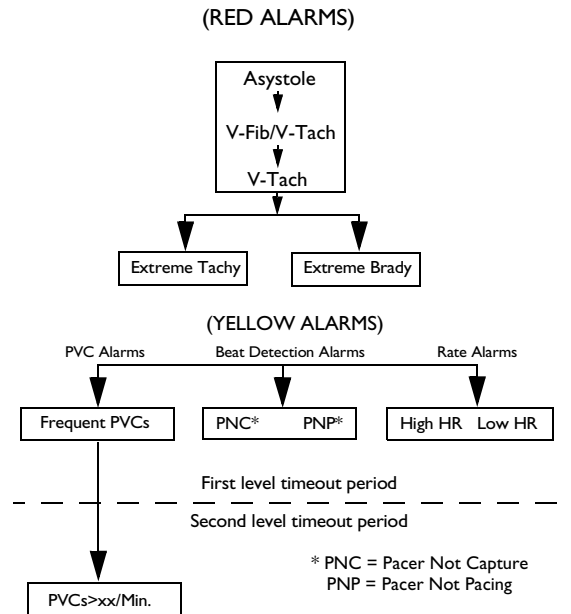


Table 6 HR/Arrhythmia Yellow Alarms

Alarm Message	Condition	Indication	Latching/ Non-Latching
HR High	The HR exceeds the configured HR high limit	Yellow alarm message, alarm tone	Non-Latching
HR Low	The HR is below the configured HR low limit	Yellow alarm message, alarm tone	Non-Latching
PVC/min High (value > limit)	The number of detected PVCs in a minute exceeds the limit of 15(adult/pedi.)	Yellow alarm message, alarm tone	Non-Latching
Pacer Not Capture	No QRS following a pacer pulse	Yellow alarm message, alarm tone	Latching
Pacer Not Pacing	No QRS or pacer pulse detected	Yellow alarm message, alarm tone	Latching

**NOTE** Pacer Alarm Messages are associated with internal/transvenous pacemakers only.

## INOP Messages

INOP messages communicate conditions that prevent the device from monitoring or analyzing the ECG. INOP messages are displayed just above the HR/Arrhythmia alarm status area. If multiple INOP conditions exist, the associated INOP messages will cycle through, alternating every 2 seconds.

**Table 7 ECG INOPs**


Alarm Message	Condition	Indication
Cannot Analyze ECG	Cannot reliably monitor the ECG in Wave Sector 1.	INOP message, INOP tone
ECG Cable Failure	During the Operational Check, a short has been detected between a lead wire and ground	INOP message, INOP tone
Leads Off	An electrode used for Wave Sector 1 may be off or not attached securely.	INOP message, INOP tone
Pads /Paddles Off	The multifunction electrode pads or paddles used as the source for the Wave Sector 1 may be off or not attached securely.	INOP message, INOP tone
ECG Unplugged	The primary ECG is derived from leads and the ECG cable is not connected.	INOP message, INOP tone
ECG Equip Malfunction	A malfunction has occurred in the ECG hardware.	INOP message, INOP tone
Pads/Paddles Cable Failure	During the Operational Check, a failure was detected in the pads or paddles cable during the pads/paddles ECG test.	INOP message, INOP tone
Pads ECG Equip Malfunction	A device hardware failure was detected.	INOP message, INOP tone

## Setting Alarms

Alarms are automatically enabled in Monitor and Pacer modes. In Manual Defib Mode alarms are automatically enabled if the Sync function is enabled. If the Sync function is not enabled, alarms are enabled in Manual Defib mode using the Alarm Pause button. Alarm settings for Heart Rate (HR) and VTACH are as configured but may be changed during operation for the current patient incident. The setting for PVC Rate Limit may only be changed in response to a PVC Rate alarm condition. Settings for other HR and arrhythmia alarms may not be changed.


### Changing Heart Rate or VTACH Alarm Limits

To change the HR or VTACH limits:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** from the menu and press the Menu Select button.
- 3 Select **HR/Arrhythmia** and press the Menu Select button.
- 4 Select **HR or VTACH Limits** and press the Menu Select button.
- 5 Using the Navigation buttons, select the new values and press the Menu Select button.

### Enabling/Disabling Heart Rate and Arrhythmia Alarms

To enable/disable the HR and Arrhythmia alarms:

- 1 Press the Menu Select  button.
- 2 Select **Measurements/Alarms** from the menu and press the Menu Select button.
- 3 Select **HR/Arrhythmia** and press the Menu Select button.
- 4 Select **Alarms On/Off** and press the Menu Select button.

## Responding to HR and Arrhythmia Alarms

When an alarm is announced, the audio pause label is presented above the Navigation and Menu Select buttons. Pressing any of these buttons temporarily silences the alarm audio while you are attending to the patient. See Figure 38. Alarms will reannunciate if conditions exist for two minutes or another alarm condition is generated.

**Figure 38 Audio Pause Label**



Then respond to the alarm condition on the HeartStart MRx. There are two ways to respond to an HR or Arrhythmia alarm:

- 1 **Acknowledge** the alarm condition.
- 2 Adjust the limits using the **New Limits** menu.


## Displaying an Annotated ECG

You may choose to display an annotated ECG with arrhythmia beat labels in Wave Sector 2. The same ECG source appearing in the Wave Sector 1 is displayed with a six second delay along with white arrhythmia beat labels. See Table 8 below for additional information on beat classification.

**Table 8 Arrhythmia Beat Labels**

Label	Description	Displayed Location
N	Normal	Above QRS
V	Ventricular Ectopic	Above QRS
P	Paced	Above QRS
'	Pacer spike	Above the waveform where the pacer spike is detected. (If the patient is both atrially and ventricularly paced, the display will show two ' marks above the waveform aligned with the atrial and ventricular pacing.)
L	Learning Patient's ECG	Above QRS
A	Artifact (noisy episode)	Above the waveform where the noise is detected.
?	Insufficient information to classify beats	Above QRS
I	Inoperative condition (e.g. LEAD OFF)	Above the waveform at start of INOP, every second of INOP, and at end of INOP.
M	Pause, Missed Beat, No QRS	Above the waveform where the condition is detected.

To display an annotated ECG:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Displayed Waves** and press the Menu Select button.
- 3 Select **Wave 2** and press the Menu Select button.
- 4 Select **Annotated ECG** and press the Menu Select button.



# Arrhythmia Learning/Relearning


When arrhythmia monitoring starts, a “learning” process is initiated. The goal is to learn the patient's normal complexes and/or paced complexes (if the patient with an internal/transvenous pacemaker is in paced rhythm). The learning process involves the first 15 valid (non-noisy) beats encountered during the learning phase.

The family selected to represent the “normal” complex includes the beat that is the most frequently seen, narrowest, on-time beat. For this reason, learning should not be initiated when the patient's rhythm is primarily ventricular.

Arrhythmia learning/relearning automatically occurs when the Therapy Knob is turned on to **Monitor**, **Pacer** or **Manual Defib**, any time there is a change in the lead selection for Wave Sector 1, and after the correction of a “**Leads or Pads Off**” INOP condition that has been active longer than 60 seconds.

Manual relearning should be initiated if the beat detection is not occurring or if beat classification is incorrect and results in a false alarm. Remember, however, that if the same signal condition which caused the algorithm to perform poorly still persists, relearning will not be able to correct the problem. The problem can only be corrected by improving the quality of the signal (e.g., by selecting a different lead.)

To initiate relearning manually,

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** from the menu and press the Menu Select button.
- 3 Select **HR/Arrhythmia** and press the Menu Select button.
- 4 Select **Relearn Rhythm** and press the Menu Select button.

The messages “**Learning ECG**” and “**Learning Rhythm**” appear in the rhythm status area of the display.

---

**WARNING** If arrhythmia relearning takes place during a ventricular rhythm or during a period of poor ECG signal quality, ectopic beats may be incorrectly learned as the normal QRS complex. This may result in missed detection of subsequent events of V-tach and high PVC rates.

For this reason, you should:

- take care to initiate arrhythmia relearning only when the ECG signal is noise-free.
  - be aware that arrhythmia relearning can happen automatically.
  - respond to any INOP messages (for example, if you are prompted to reconnect electrodes).
  - display an annotated wave to ensure beat labels are correct.
- 

## Troubleshooting

If your HeartStart MRx does not operate as expected during ECG and Arrhythmia monitoring, see “Troubleshooting” on page 249.



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# Semi-Automated External Defibrillation

Defibrillation therapy is the definitive method for termination of a variety of potentially fatal arrhythmias. The HeartStart MRx's Semi-Automated External Defibrillation (AED) Mode is designed to guide you through standard treatment algorithms for cardiac arrest. The HeartStart MRx provides therapy through the application of a brief biphasic pulse of electricity to the cardiac muscle. This electrical energy is transferred through disposable multifunction electrode pads applied to the patient's bare chest.

Configuration choices allow you to customize AED Mode to better meet the unique needs of your organization or resuscitation team. This chapter describes how to use AED Mode. It explains the prompts that guide you through the defibrillation process and describes how prompts vary depending upon the condition of the patient and the configuration of your device.

For information on annotating, storing, and printing event information acquired in AED Mode, see "Data Management" on page 203.

For information on setting configuration choices, see "Configuration" on page 181.

## Precautions for AED Therapy

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**WARNING** The AED algorithm is not designed to handle erratic spiking problems caused by a properly or improperly functioning pacemaker. In patients with cardiac pacemakers, the HeartStart MRx may have reduced sensitivity and not detect all shockable rhythms.

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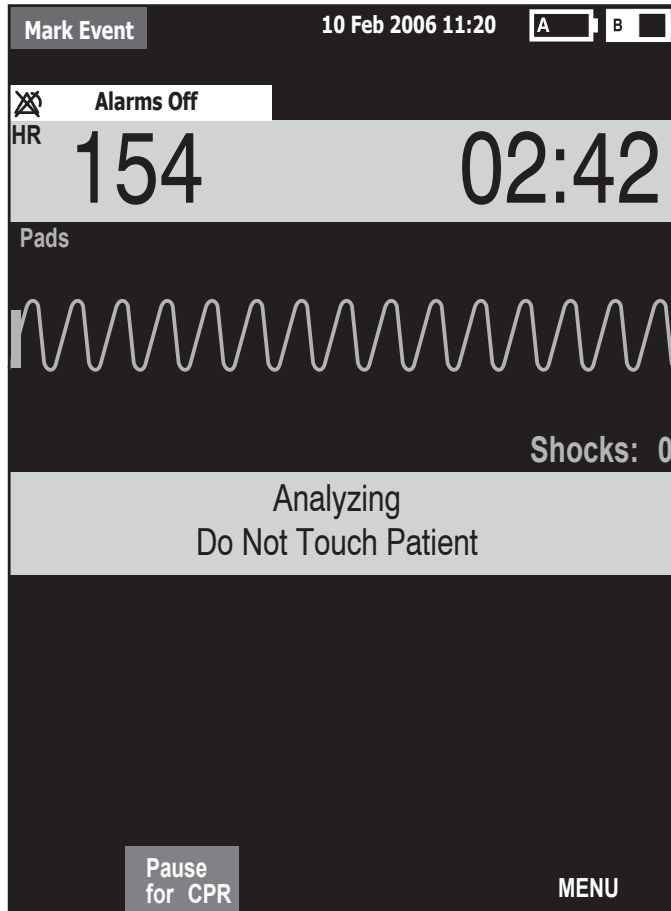
**NOTES** The Philips HeartStart MRx AED mode is not intended for children under 8 years of age. For children 8 years of age and older, the American Heart Association recommends that standard operating procedures for AEDs be followed. See the American Heart Association *Guidelines 2005 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*. Dallas, Texas; AHA; 2005.

Successful resuscitation is dependent on many variables specific to the patient's physiological state and the circumstances surrounding the patient incident. Failure to have a successful patient outcome is not a reliable indicator of monitor/defibrillator performance. The presence or absence of a muscular response to the transfer of energy during electrical therapy is not a reliable indicator of energy delivery or device performance.

## AED View

Once the Therapy Knob is moved to AED, AED View is displayed.

Figure 39 AED View Display



Wave Sectors 1 and 2 are combined so that a large ECG may be shown. The Event Timer is also large for easier viewing. A Shock Counter is displayed just below the ECG and shows the total number of shocks delivered to the patient in AED and Manual Defib Mode. Also below the ECG is a prominent text message window which accompanies the voice prompts annunciated in AED Mode.

**NOTE** Only the ECG acquired through multifunction electrode pads is displayed in AED Mode.

# Preparation

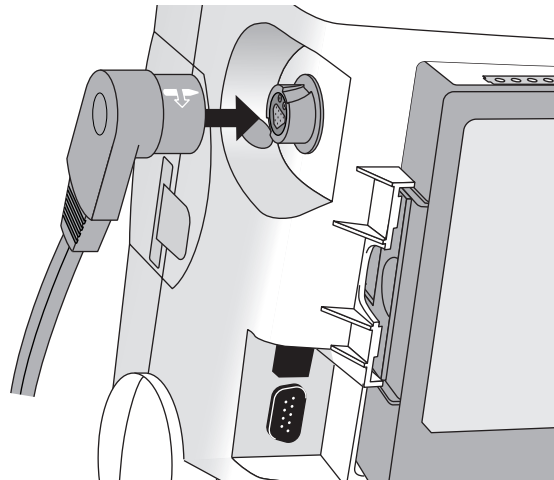
Confirm that the patient is:

- unresponsive
- not breathing
- pulseless

Then:

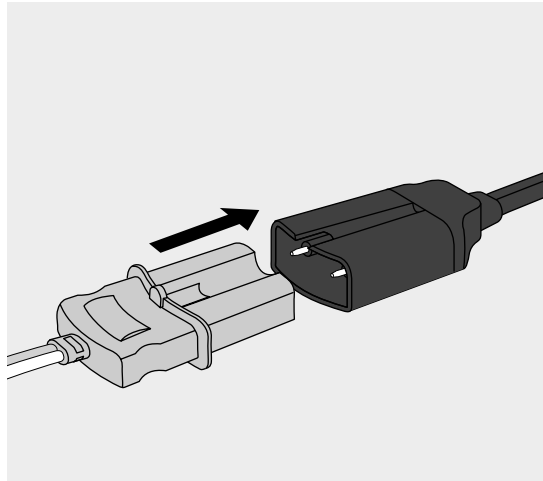
- 1 Remove clothing from the patient's chest. Wipe moisture from the patient's chest and, if necessary, clip or shave excessive chest hair.
- 2 Make sure the multifunction electrode pads packaging is intact and within the expiration date shown.
- 3 Apply multifunction electrode pads to the patient as directed on the pads package. Use the anterior-anterior electrode placement.
- 4 If not pre-connected, insert the pads cable into the green Therapy port located on the right side of the device. See Figure 40.

**Figure 40 Pads Cable Connection**



- 5 Connect the pads to the pads cable as shown in Figure 41.

**Figure 41 Pads Connection**



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**WARNING** Do not use anterior-posterior pads placement (multifunction electrode pads placed on the patient's chest and back). The AED algorithm used by the HeartStart MRx has not been validated using this placement.

---

---

**WARNING** Do not let the multifunction electrode pads touch each other or other monitoring electrodes, lead wires, dressings, transdermal patches, etc. Such contact can cause electrical arcing and patient skin burns during defibrillation and may divert defibrillation current away from the heart.

---

---

**WARNING** During defibrillation, air pockets between the skin and multifunction electrode pads can cause patient skin burns. To help prevent air pockets, make sure defibrillation pads completely adhere to the skin. Do not use dried-out multifunction electrode pads.

---

---

**CAUTION** Aggressive handling of multifunction electrode pads in storage or prior to use can damage the pads. Discard the pads if they become damaged.

---

**NOTE** Impedance is the resistance between the defibrillator's pads or paddles that the defibrillator must overcome to deliver an effective discharge of energy. The degree of impedance differs from patient to patient and is affected by several factors including the presence of chest hair, moisture, and lotions or powders on the skin.

The low-energy SMART Biphasic waveform is an impedance-compensating waveform that is designed to be effective across a wide range of patients. However, if you receive a "No Shock Delivered" message, check that the patient's skin has been washed and dried and that any chest hair has been clipped. If the message persists, change the pads and/or the pads cable.

## Using AED Mode

To operate the HeartStart MRx in AED Mode, follow these three basic steps:

- 1 Turn the Therapy Knob to AED.
- 2 Follow the voice and screen prompts.
- 3 Press the orange Shock button, if prompted.

These steps are described more fully in the sections that follow.

While operating in AED Mode, the capabilities of the device are limited to those essential to the performance of semi-automated external defibrillation. Only the ECG acquired through pads is displayed. Previously set alarms and scheduled measurements are indefinitely paused and entry of patient information is disabled. Additionally, the Sync, Lead Select, and Alarm Pause buttons are inactive.

### Step 1 - Turn the Therapy Knob to AED

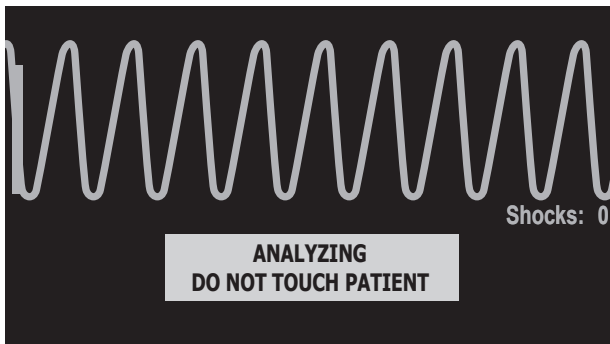
When the HeartStart MRx is turned on in AED Mode, it checks to see if the pads cable and multifunction electrode pads are properly connected. If the:

- pads cable is not properly attached, you are prompted to **"Connect Pads Cable"**.
- multifunction electrode pads are not connected to the pads cable, pads are not applied to the patient, or pads are not making proper contact with the patient's skin, you are prompted to **"Apply Pads"** and **"Plug in Connector"**.

## Step 2 - Follow the Screen and Voice Prompts

Once an ECG is detected through the multifunction electrode pads, the HeartStart MRx automatically analyzes the patient's heart rhythm and warns you not to touch the patient (Figure 42).

Figure 42 ECG Analysis Screen in AED Mode




---

**WARNING** Handling or transporting the patient during ECG rhythm analysis can cause an incorrect or delayed diagnosis. Under these circumstances, if the HeartStart MRx issues a **"Shock Advised"** prompt, keep the patient as still as possible for at least 10 seconds so the HeartStart MRx can reconfirm the rhythm analysis before you deliver a shock.

---

If artifact interferes with analysis, the message **"Analyzing Interrupted, Do Not Touch the Patient"** is announced while the HeartStart MRx attempts to continue analyzing. If the artifact persists, the message **"Cannot Analyze"** is announced and the message **Paused. Attend To Patient** is displayed. While paused, analysis is suspended. Check that the pads are making proper contact with the patient's skin and minimize movement. Analysis resumes automatically after 30 seconds or when you press **[Resume Analyzing]**.

Always use the analyze function to determine if a rhythm is shockable.

### Adjusting Voice Prompt Volume

You may adjust the volume of the voice prompts at any time by accessing the Voice Volume menu.

Press the Menu Select  button.

Select the desired volume level and press the Menu Select button.

**NOTE** In loud environments, you can use the display prompts in lieu of voice prompts.

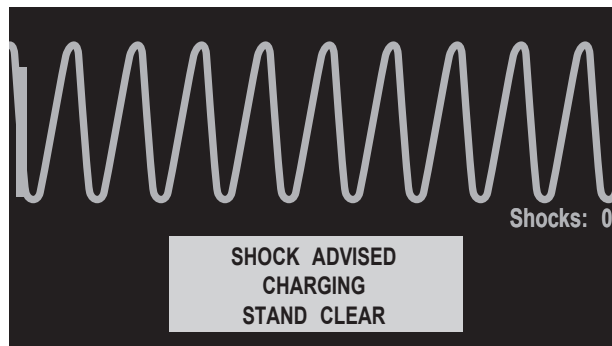


## Shock Advised

If a shockable rhythm is detected, the HeartStart MRx automatically charges to 150J. Charging is accompanied by voice and screen prompts as shown in Figure 43. A steady high-pitched tone is sounded, and the orange Shock button flashes when the device is fully charged.

Heart rhythm analysis continues while the HeartStart MRx charges. If a rhythm change is detected before the shock is delivered and a shock is no longer appropriate, the defibrillator disarms.

**Figure 43 Shock Advised, Charging Display**



**NOTE** When the HeartStart MRx is fully charged, you can disarm it any time by turning the Therapy Knob to the “Off” position or by pressing the **[Pause for CPR]** soft key. Resume monitoring the patient by turning the Therapy Knob back to AED.

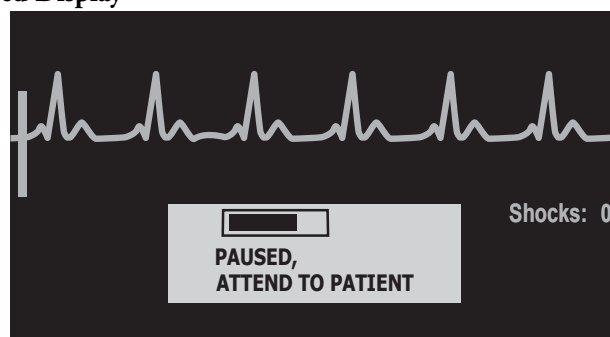
## No Shock Advised (NSA)

If a shockable rhythm is not detected, the HeartStart MRx tells you, “**No shock advised**”. If the NSA Action Configuration Choice is set to:

**Monitor** - the HeartStart MRx monitors the ECG and automatically resumes analysis if a potentially shockable rhythm is detected. You are periodically prompted to “**If needed, press Pause and begin CPR.**” The frequency of these prompts is defined in the Monitor Prompt Interval Configuration Choice. You may press **[Pause for CPR]** to suspend monitoring and administer CPR. The pause period is defined by the CPR Timer Configuration Choice.

**Pause Time**- analysis is suspended for the specified period and you may administer CPR and attend to the patient. A Pause status bar is displayed as shown in Figure 44. The pause period is defined by the NSA Action Configuration Choice. At the completion of the pause period, the HeartStart MRx resumes analyzing.

**Figure 44 Paused Display**



### Step 3 - Press the Orange Shock Button, if Prompted

Once charging is complete, the HeartStart MRx prompts you to **"Deliver Shock Now; Press the Orange Button Now"**. Make sure no one is touching the patient or anything connected to the patient. Call out clearly and loudly, "Stay Clear." Then press the orange Shock button to deliver a shock to the patient.

---

**WARNING** Defibrillation can cause operator or bystander injury. Do not touch the patient or equipment connected to the patient during defibrillation.

---

**WARNING** The Shock button must be pressed to deliver a shock. The HeartStart MRx will not automatically deliver a shock.

---

Delivery of the shock is confirmed by the message **"Shock Delivered"** and the shock counter on the display is updated to reflect the number of shocks given. The defibrillator will announce **"Paused. If needed, begin CPR."** The HeartStart MRx pauses for the configured CPR Timer period. Prompts may be brief or detailed, as defined by the CPR Prompt Configuration Choice. Analysis begins again at the completion of the pause period or when you press **[Resume Analyzing]**.

If you press **[Pause for CPR]** after a shock is delivered in the current Shock Series, the length of the CPR Pause is defined by the CPR Timer Configuration Choice.

**NOTE** You may return to analyzing the patient's heart rhythm at any time by pressing the **[Resume Analyzing]** soft key.

**NOTE** Once prompted to **"Deliver Shock Now; Press the Orange Button Now"**, if you do not do so within the configured Auto Disarm time interval, the HeartStart MRx disarms itself and provides a pause for CPR. The device resumes analyzing at the end of the configurable pause period or when the **[Resume Analyzing]** soft key is pressed.

**NOTE** Rhythm Monitoring is intended to provide a backup or secondary measure of potentially shockable rhythms in various environments but is not a substitute for being attentive to the state of the patient.

### Using Q-CPR in AED mode

If your HeartStart MRx is equipped with the Q-CPR option, refer to "Using Q-CPR in AED Mode" on page 174.

## Troubleshooting

If your HeartStart MRx does not operate as expected during defibrillation, see "Troubleshooting" on page 249.

---

# Manual Defibrillation and Cardioversion

This chapter explains how to prepare for and perform asynchronous and synchronous (cardioversion) defibrillation using multifunction electrode pads, external paddles, and internal paddles.

**NOTE** Defibrillation is always performed through paddles or pads. However, during defibrillation you may choose to monitor the ECG using an alternate ECG source (3-, 5-, or 10-lead monitoring electrodes). If an alternate ECG source is connected, any available lead may be displayed.


For information on monitoring optional measurements while in Manual Defib Mode, see the corresponding chapters in these *Instructions for Use*.

## Overview

Defibrillation therapy is the definitive method for termination of a variety of potentially fatal arrhythmias. The HeartStart MRx provides this therapy through the application of a brief biphasic pulse of electricity to the cardiac muscle. This electrical energy is transferred through attached paddles or disposable multifunction electrode pads applied to the patient's bare chest. Internal paddles for open-chest intrathoracic defibrillation can also be used.

In Manual Defib Mode, you must assess the ECG, decide if defibrillation or cardioversion is indicated, select the appropriate energy setting, charge the monitor/defibrillator, and deliver the shock. The entire defibrillation process is under your control. Voice prompts are not present. However, text messages on the display provide relevant information throughout the process. It is important to be attentive to these messages when displayed.

The ECG strip and Event Summary are easily annotated with event information using the Mark Event function button. See "Marking Events" on page 212 for more information.

Monitoring alarms are available in Manual Defib Mode, however, they are turned off once an energy is selected for defibrillation unless Sync is active. Alarms may be turned on in Manual Defib Mode by pressing the Alarm Pause  button. Alarms are also reactivated once the Therapy Knob is moved to **Monitor** or **Pacer** or Sync is selected.

When an energy is selected, automatic NBP measurements are discontinued. If a manual NBP measurement is requested by pressing the **[Start NBP]** soft key, the NBP information, including the current schedule, is displayed in its normal position, and scheduled NBP measurements resume.

**NOTE** The use of Manual Defib Mode may be password protected, as defined in Configuration. See "Password Security" on page 15.

## Precautions for Manual Defibrillation Therapy

Defibrillating asystole can inhibit the recovery of natural pacemakers in the heart and completely eliminate any chance of recovery. Asystole should not be routinely shocked.

## Synchronized Cardioversion Therapy

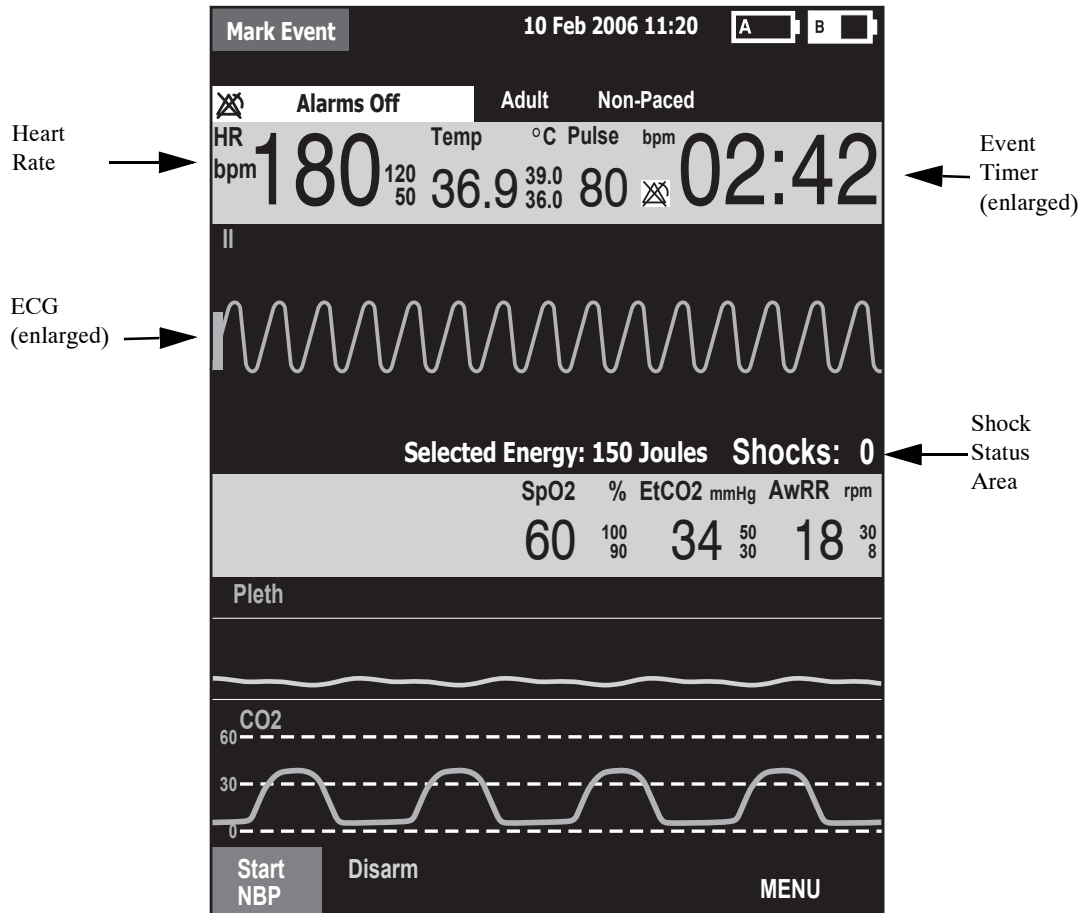
The HeartStart MRx provides synchronized cardioversion therapy by delivering a brief biphasic pulse of electricity to the cardiac muscle immediately following an R-wave detected in the ECG measurement. The SMART Biphasic waveform utilized in the HeartStart MRx has undergone clinical testing demonstrating its effectiveness for cardioversion of atrial fibrillation.

**NOTE** Successful resuscitation is dependent on many variables specific to the patient's physiological state and the circumstances surrounding the patient event. Failure to have a successful patient outcome is not a reliable indicator of monitor/defibrillator performance. The presence or absence of a muscular response to the transfer of energy during electrical therapy is not a reliable indicator of energy delivery or device performance.

## Code View

In Manual Defib Mode, an energy is selected and the Code View is displayed. Code View is optimized to clearly communicate data associated with a resuscitation event. Notice the increased prominence of the Event Timer, as well as the enlarged ECG in Wave Sectors 1 and 2 as shown in Figure 45.

**Figure 45 Code View Display**



**NOTE** The Shock Counter displays the number of shocks delivered while in AED and Manual Defib modes.

## Preparing for Defibrillation

In preparation for defibrillation:

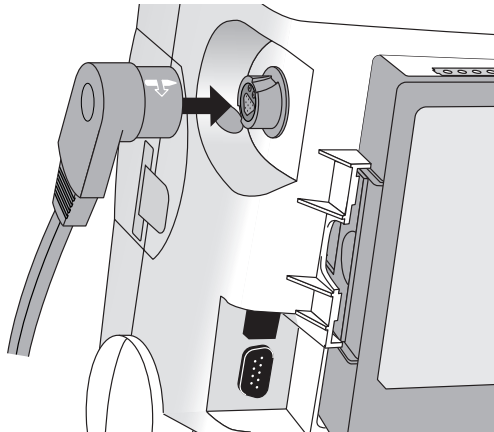
- 1 Connect the appropriate Therapy cable.
- 2 Apply the paddles or pads as described below.

### Using Multifunction Electrode Pads

To prepare for defibrillation using multifunction electrode pads:

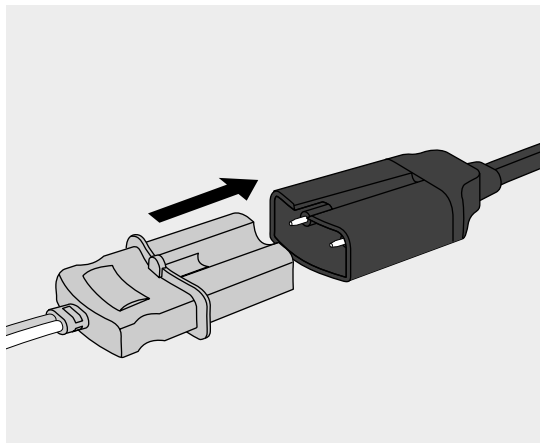
- 1 If not pre-connected, connect the pads cable to the HeartStart MRx by aligning the white pointer on the pads cable connector with the white arrow on the green Therapy port. Then push until you hear it click into place. See Figure 46.

**Figure 46 Pads/Internal Paddles Cable Connection**



- 2 Check the expiration date that appears on the pads package.
- 3 Inspect the packaging for any damage.
- 4 Connect the pads connector to the pads cable. See Figure 47.

**Figure 47 Pads Connector**



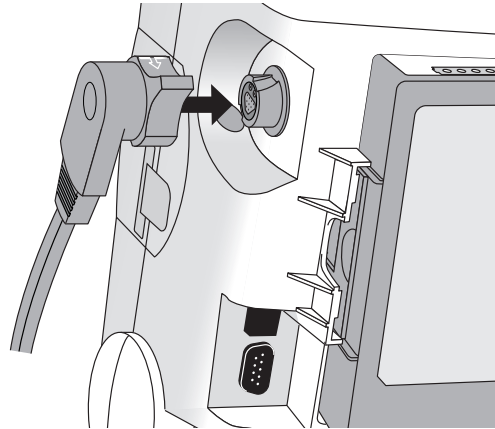
- 5 Apply the pads to the patient as directed on the pads packaging or according to your organization's protocol.

## Using External Paddles

To defibrillate using external paddles:

- 1 If not pre-connected, connect the paddles cable to the HeartStart MRx by aligning the white pointer on the paddles cable connector with the white arrow on the green Therapy port. Then push until you hear it click into place. See Figure 48.

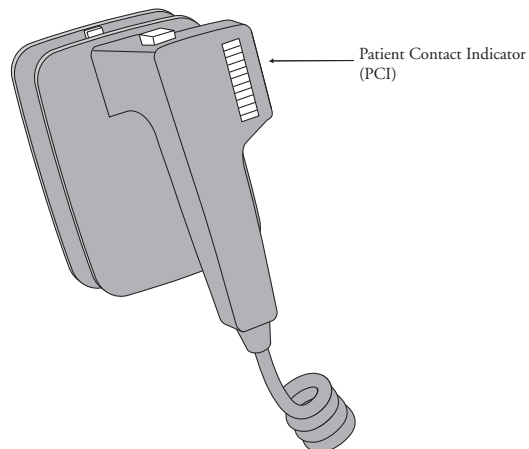
**Figure 48 Paddles Cable Connection**



- 2 Remove the Paddle Set from the Paddle Tray by pulling the paddles straight up and out of the paddle tray.
- 3 Apply conductive matter to the paddle electrodes.  
Do not distribute conductive matter by rubbing the paddle electrodes together.
- 4 Apply paddles to the patient's bare chest, using the anterior-anterior placement (or in accordance with your organization's protocol).

The sternum paddle contains a patient contact indicator (PCI). See Figure 49. If necessary, as indicated by the appearance of either a red or orange LED on the PCI, adjust paddle pressure and placement to optimize patient contact. Once proper contact is made, the PCI shows a green LED.

**Figure 49 Patient Contact Indicator**



**NOTE** Reasonable effort should be made to obtain a reading of at least one green LED. Due to impedance, this may not be possible for some patients, and orange LEDs may be the best that can be achieved.

## Using Pediatric Paddles

The HeartStart MRx's external paddle set comes with pediatric paddles included. The American Heart Association recommends using pediatric paddles on children weighing < 10 Kg (larger paddles may be used as long as contact between the paddles is avoided).

To use the pediatric paddles set:

- 1 Depress the latch at the front of the external paddle set while pulling forward on the adult paddle electrode.
- 2 Store the adult paddle electrodes in the paddle tray pockets.
- 3 To defibrillate, see "Using External Paddles" on page 75.

**NOTE** Impedance is the resistance between the defibrillator's pads or paddles that the defibrillator must overcome to deliver an effective discharge of energy. The degree of impedance differs from patient to patient and is affected by several factors including the presence of chest hair, moisture, and lotions or powders on the skin.

The low-energy SMART Biphasic waveform is an impedance-compensating waveform that is designed to be effective across a wide range of patients. However, if you receive a "No Shock Delivered" message, check that the patient's skin has been washed and dried and that any chest hair has been clipped. If the message persists, change the pads and/or the pads cable.

## Using Internal Paddles

To defibrillate using internal paddles:

- 1 Select the appropriate paddle electrode size.
- 2 If using switchless internal paddles, connect the paddles to the M4740A Paddle Adapter Cable.
- 3 Connect the paddles cable (or the paddle adapter cable) to the HeartStart MRx by aligning the pointer on the paddles cable (or paddle adapter cable) with the white arrow on the green Therapy port. Then push until you hear it click into place. See Figure 46.

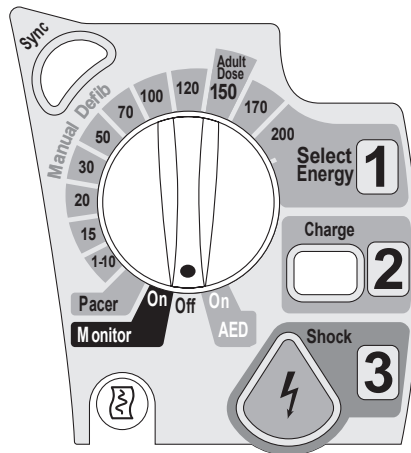


## Defibrillating (asynchronously)

Once you have performed the necessary preparation for defibrillation, perform the following steps:

- 1 **Select Energy** - To select the energy setting, rotate the Therapy Knob to the desired energy level as shown in Figure 50. Energy choices range from 1 to 200, with 150J the recommended level for adult patients.

**Figure 50 Energy Selection**



Selecting the 1-10 (1-9) energy setting displays the Select Energy menu, with a default setting of 6J. The low energy setting can be changed using the Navigation buttons to increase or decrease the desired setting. Complete your selection by pressing the Menu Select (✓) button. Your current energy selection is shown in the Shock Status area of the display as shown in Figure 45.

---

**WARNING** Clinicians must select an appropriate energy level for defibrillation of pediatric patients.

---



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**WARNING** The HeartStart MRx has a built-in limitation of 50 Joules when using internal paddles.


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**WARNING** Do not leave patients unattended when the HeartStart MRx is in manual defibrillation mode with pads applied to the patient.

---


- Charge** - Press the Charge  button on the front panel. If using external paddles, the charge button on the paddles may be used instead. As the defibrillator charges, the energy selection shown in the Shock Status area changes to show the current charge energy. A continuous, low-pitch charging tone sounds until the desired energy level is reached, at which point you will hear a continuous, high-pitch charge done tone.

You may increase or decrease the selected energy at any time during charging or after charging is complete. Simply move the Therapy Knob to the desired energy level as explained above. The defibrillator charges to the selected energy level automatically.

To disarm the defibrillator, press [**Disarm**]. 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.

- Shock** - Confirm that a shock is still indicated and that the defibrillator has charged to the selected energy level. Make sure no one is touching the patient or anything connected to the patient. Call out loudly and clearly, “Stay Clear!”

If using:

- pads or switchless internal paddles, press the flashing Shock  button to deliver a shock to the patient.
- external paddles, simultaneously press the shock buttons located on the paddles to deliver a shock to the patient.
- switched internal paddles, press the Shock button located on the paddles to deliver a shock to the patient.

The number of shocks delivered is displayed in the Shock Status area of the display. This number includes any shocks administered while in AED Mode.

---

**WARNING** Defibrillation current can cause operator or bystander injury. Do not touch the patient, or equipment connected to the patient, during defibrillation.

---

---

**CAUTION** Alarms are turned off when an energy is selected for asynchronous defibrillation, and the “Alarms Off” message is displayed. Alarms remain paused until toggled on using the Alarm Pause button, the Sync function is enabled, or the Therapy Knob is moved to **Monitor** or **Pacer**.

---

# Performing Synchronized Cardioversion


Synchronized Cardioversion allows you to synchronize delivery of the defibrillator shock with the R-wave of the ECG being monitored in Wave Sector 1. You may choose to perform synchronized cardioversion through either:

- multifunction electrode pads, or
- external paddles

When using paddles, you should monitor the ECG through monitoring electrodes connected to a 3-, 5- or 10-lead ECG cable or a Philips bedside monitor. You may choose to monitor through an alternate source when using pads, as well. Cardioversion is still delivered through either pads or paddles.

## Preparing for Synchronized Cardioversion

In preparation for synchronized cardioversion:

- 1 Perform the tasks as described in “Preparing for Defibrillation” on page 74
- 2 If monitoring through a 3-, 5-, or 10-lead ECG cable, plug the ECG cable into the ECG port on the HeartStart MRx and apply monitoring electrodes to the patient. (See “ECG and Arrhythmia Monitoring” on page 47.)
- 3 Use the Lead Select  button to select pads, paddles or a lead from attached monitoring electrodes. The selected ECG source should have a clear signal and a large QRS complex. (See “Lead Selection” on page 53.)




**NOTE** When the patient is already connected to Philips bedside monitoring equipment, an external ‘Sync’ cable plugs into the ECG Output jack of the bedside monitor and connects to the ECG port of the HeartStart MRx. This connects the ECG signal from the monitor into the HeartStart MRx, where it is displayed and synchronization occurs.

The signal from the bedside monitor is displayed as Lead II on the HeartStart MRx, even though it is not necessarily Lead II coming from the bedside monitor.

- 
- WARNING**
- If you use an external monitor as the ECG source, a biomedical technician **MUST** verify that the external monitor and the HeartStart MRx 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.
  - When monitoring through paddles only, artifact introduced by paddle movement may resemble an R-wave and trigger a defibrillation shock.
-


## Delivering a Synchronized Shock


To perform synchronized cardioversion:

- 1 With the Therapy Knob in the **Monitor** position, press the Sync  button located beside the Therapy Knob (see Figure 50) to activate the Sync function. A Sync message appears in the upper right corner of Wave Sector 1.
- 2 Confirm that the Sync marker appears with each R-wave.
- 3 Turn the Therapy Knob to the desired energy level setting.
- 4 Press the Charge  button on the HeartStart MRx or, if using paddles, the yellow charge button located on the handle of the paddle with the  symbol. Wait until the charge has reached the energy level selected, and you hear a continuous charge done tone.

To disarm the defibrillator, press **[Disarm]**. If Shock has not been pressed within the time period specified in the Time to Auto Disarm Configuration Choice, the defibrillator disarms automatically.

If desired, you may increase or decrease the selected energy level after pressing the Charge button by moving the Therapy Knob to the desired setting. The defibrillator charges to the modified energy level automatically. Wait until the current charge reaches the selected energy level before proceeding.

- 5 Make sure no one is touching the patient or anything connected to the patient. Call out clearly and loudly, “Stay Clear!”.
- 6 Press **and hold** the Shock  button on the HeartStart MRx or, if you are using external paddles, press **and hold** the orange buttons on both paddles. The shock will be delivered when the next R-wave is detected.

**NOTE** It is important to continue to hold the Shock  button (or the paddle shock buttons) until the shock is delivered. The defibrillator shocks with the next detected R-wave.

**NOTE** Should an ECG or pads INOP (such as Leads Off) occur while performing synchronized cardioversion, the HeartStart MRx will not charge, or if charged, will disarm automatically.

---

**WARNING** Defibrillation current can cause operator or bystander injury. Do not touch the patient or equipment connected to the patient during defibrillation.

---


## Delivering Additional Synchronized Shocks

If additional synchronized shocks are indicated, perform the following steps:

- 1 Make sure the Sync function is still enabled, as indicated by the presence of the Sync message in the upper right corner of the Wave Sector 1.
- 2 Repeat Steps 4-6 under “Delivering a Synchronized Shock”.

The Sync function of the HeartStart MRx can be configured to either be enabled or disabled after each shock is delivered. If configured to remain enabled and the Therapy Knob is moved to either **Monitor** or **Pacer**, the Sync function is still enabled. However, should the Therapy Knob be moved to either the **Off** or **AED** positions, the Sync function is disabled.

## Disabling the Sync Function

To turn off the Sync function of the HeartStart MRx, press the Sync  button.

## Using Q-CPR in Manual Mode

If your HeartStart MRx has the Q-CPR option, refer to “Using Q-CPR in Manual Defib Mode” on page 170.

## Troubleshooting

If your HeartStart MRx monitor/defibrillator does not operate as expected during defibrillation, see “Troubleshooting” on page 249.



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# Noninvasive Pacing

This chapter explains the noninvasive transcutaneous pacing option available with the HeartStart MRx and describes how to perform pacing.

## Overview

Noninvasive transcutaneous pacing therapy is used to deliver pace pulses to the heart. Pace pulses are delivered through multifunction electrode pads that are applied to the patient's bare chest.

While in Pacer Mode, the ECG strip and Event Summary are easily annotated with event information using the Mark Event function button. See "Marking Events" on page 212 for more information.

- NOTE** For treatment of patients with implantable devices such as permanent pacemakers or cardioverter-defibrillators, consult a physician and the instructions for use provided by the device's manufacturer.
- NOTE** Waveforms, ECG monitoring, measurements, and most alarms remain active and retain their settings when you transition from Monitor or Manual Defib Mode to Pacer Mode. However, the waveform displayed in Wave Sector 4 is replaced by the pacing status bar.
- NOTE** The use of Pacer Mode may be password protected as defined in Configuration. See "Password Security" on page 15.

# Alarms

Arrhythmia alarms for Pacer Not Pacing and Pacer Not Capture are associated with non-transcutaneous pacing (such as internal, transvenous or epicardial pacing), therefore, these alarms are off when the HeartStart MRx is in Pacer Mode. All other red and yellow alarms are active if enabled, and their limits may be changed while in Pacer Mode. Refer to the specific chapter for each measurement for information on red and yellow alarms and changing alarm limits.

While pacing, should a Pads Off condition occur or the pads cable get disconnected, a latching, red alarm is generated and pacing is stopped. The message, **Pacing Stopped. [Pads Off] [Pads Cable Off]** is displayed in the top line of the pacing status bar. Once the condition is corrected, resume pacing by pressing the **[Resume Pacing]** soft key.

While pacing in demand mode, should the ECG source for Wave Sector 1 become invalid, e.g. a Leads Off condition or the ECG cable is disconnected, a latching, red alarm is generated and pacing is stopped. The message, **Pacing Stopped. Leads Off.** is displayed in the top line of the pacing status bar. Once the condition is corrected, resume pacing by pressing the **[Resume Pacing]** soft key.

When pacing in demand mode using a 3-lead ECG set, if the lead in Wave Sector 1 is changed, a latching, red alarm is generated. The message, **Pacing Stopped. Leads Off.** is displayed in the top line of the pacing status bar. Resume pacing by pressing the **[Resume Pacing]** soft key.

**NOTE** The Pacing Stopped red alarm cannot be disabled.

---

**WARNING** Heart rate displays and alarms function during pacing, but they can be unreliable. Observe the patient closely while pacing. Do not rely on the indicated heart rate or heart rate alarms as a measure of the patient's perfusion status.

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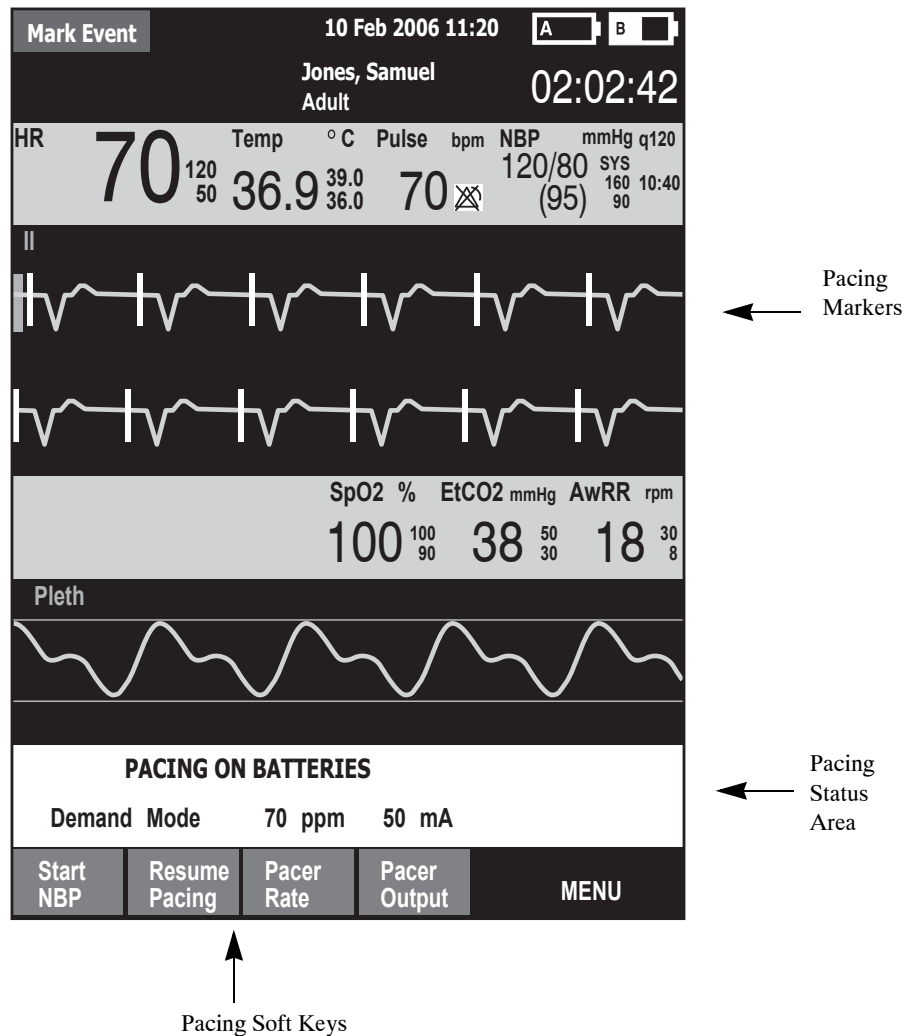
**NOTE** When pacing is stopped due to a power interruption, a red **Pacing Stopped. Power Interrupted** alert will appear on the HeartStart MRx display when power is eventually restored.



# Pacing View

Pacing View appears when the Therapy Knob is set to the **Pacer** position. Figure 51 shows information displayed in Pacing View.

Figure 51



Pacing View includes a status block which appears in Wave Sector 4 of the display. The first line of the status block communicates whether pacing is active or paused. If pacing is powered by batteries, this is indicated here as well, if configured. The second line of the status block identifies the Pacer Mode (demand or fixed), pacing rate (ppm), and pacing output (mA).

Soft keys are available for setting pacing status ([**Start Pacing**], [**Pause Pacing**], [**Resume Pacing**]) and adjusting [**Pacer Rate**], [**Pacer Output**].

**NOTE** If pacing is interrupted for any reason, the [**Resume Pacing**] soft key must be pressed to continue pacing.

A white pacing marker appears on the ECG waveform in Wave Sector 1 each time a pacer pulse is delivered to the patient. If pacing in demand mode, white R-wave markers also appear on the ECG until capture occurs.

**NOTE** R-wave markers do not appear on paced beats.

## Demand Mode Versus Fixed Mode

The HeartStart MRx can deliver paced pulses in either demand or fixed mode.

- In **demand mode**, the pacer only delivers paced pulses when the patient's heart rate is lower than the selected pacing rate.
- In **fixed mode**, the pacer delivers paced pulses at the selected rate.

---

**WARNING** Use demand mode pacing whenever possible. Use fixed mode pacing when motion artifact or other ECG noise makes R-wave detection unreliable or when monitoring electrodes are not available.

---

The HeartStart MRx requires a 3-, 5-, or 10-lead ECG cable and monitoring electrodes as the source of the ECG during demand pacing. Pace pulses are delivered through the multifunction electrode pads. However, the pads cannot be used to monitor the ECG and deliver pace pulses simultaneously.

**NOTE** The ECG derived from pads does not need to be displayed in a wave sector in order to deliver pacing therapy.

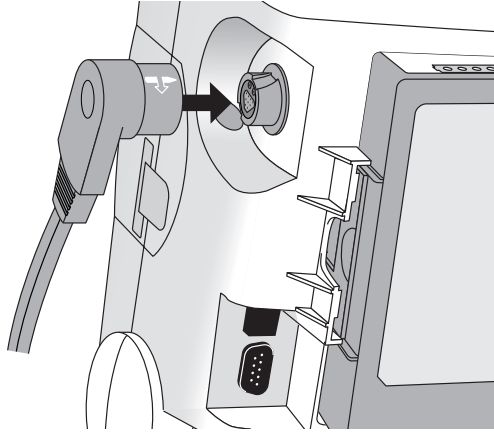
**NOTE** When using demand mode, pads are not an available choice for display in Wave Sector 1, through either the Lead Select button or the **Displayed Waves** menu.

# Preparing for Pacing

To prepare for pacing:

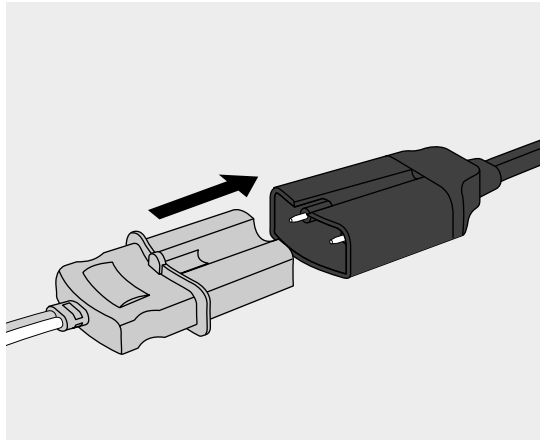
- 1 If not pre-connected, connect the pads cable to the HeartStart MRx by aligning the white pointer on the pads cable with the white arrow on the green Therapy port. Then push until you hear it click into place. See Figure 52.

**Figure 52 Pads Cable Connection**



- 2 Make sure the multifunction electrode pads packaging is intact and within the expiration date shown.
- 3 Connect the pads connector to the pads cable. See Figure 53.

**Figure 53 Pads Connector**



- 4 Apply the pads to the patient as directed on the pads packaging or according to your organization's protocol. Prepare the patient's skin prior to applying the pads. Skin is a poor conductor of electricity, so skin preparation is important in achieving good contact.
  - If necessary, clip hair at the electrode sites (or shave sites if needed).
  - Clean and abrade the skin at the electrode site.
  - Dry the electrode sites briskly to increase capillary blood flow in the tissues and to remove oil and skin cells.

- 5 If pacing in demand mode, apply monitoring electrodes (see “Electrode Placement” on page 51), and connect the ECG cable to the HeartStart MRx (see “Connecting the ECG Cable” on page 35).

**NOTE** If pacing for long periods of time, new monitoring electrodes and multifunction electrode pads should be applied periodically. Refer to the manufacturer’s documentation for replacement recommendations.


**NOTE** The signal from a TENS unit can cause ECG artifact which may impact pacing.

## Demand Mode Pacing

To pace in demand mode:

- 1 Turn the Therapy Knob to the **Pacer** position.

The message, **Pacing Paused**, appears in the status block and indicates that the pacing function is enabled, however, pace pulses are not being delivered. Pacing is enabled in demand mode, with the configured lead displayed in Wave Sector 1. If the configured lead is set to Pads, Lead II or the first available monitoring lead is displayed.

- 2 Press the Lead Select  button to select the best lead with an easily detectable R-wave. (See “Lead Selection” on page 53).

**NOTE** If you are using anterior-anterior pads placement while pacing and are experiencing difficulty with Lead II, select another lead.

- 3 Verify that white R-wave markers appear above or on the ECG waveform. A single marker should be associated with each R-wave. If the R-wave markers do not appear or do not coincide with the R-wave, select another lead.
- 4 Press [**Pacer Rate**] and use the Navigation and Menu Select buttons to select the desired number of pace pulses per minute. The initial rate is configurable.
- 5 If needed, adjust the initial pacer output. To do this, press [**Pacer Output**] and use the Navigation and Menu Select buttons to select the desired output. The initial output is configurable.
- 6 Press [**Start Pacing**]. The message, **Pacing**, appears.

---

**WARNING** Use care when handling the multifunction electrode pads on the patient to avoid shock hazard during pacing.

---

- 7 Verify that white pacing markers appear on the ECG waveform.
- 8 Press [**Pacer Output**]. Then use the Navigation and Menu Select buttons to:
  - a. increase the output until cardiac capture occurs. Capture is indicated by the appearance of a QRS complex after each pacing marker.
  - b. decrease the output to the lowest level that still maintains capture.
- 9 Verify the presence of a peripheral pulse.

**NOTE** Spontaneous beats may be present which are not associated with the delivery of pace pulses. Additionally, if the patient's heart rate is above the pacer rate, pace pulses are not delivered and, therefore, pacing markers do not appear.

To stop delivery of pace pulses, press [**Pause Pacing**]. Once paused, press [**Resume Pacing**] to resume delivery of pace pulses.

You may also stop delivery of pace pulses by moving the Therapy Knob off the **Pacer** position.

---

**WARNING** When Pacing in demand mode, the ECG cable must be directly connected from the patient to the HeartStart MRx.

---



---

**WARNING** If you are using the pacing function with battery power and the Low Battery Alarm is annunciated, connect the device to external power or insert a fully charged battery.

---

**NOTE** Routinely assess the patient's cardiac output by assessing peripheral pulses.

**NOTE** Pacing will not start if there is a problem with the multifunction electrode pads connection or patient contact. Pace pulses will not be delivered if there is a problem with the ECG monitoring electrodes connections. If either situation occurs, a system message is displayed to alert you that a lead is disconnected or that the pads have a poor connection.

## Fixed Mode Pacing

To pace in fixed mode:

- 1 Turn the Therapy Knob to the **Pacer** position.


The message, **Pacing Paused**, appears and indicates that the pacing function is enabled, however, pace pulses are not being delivered. Pacing is enabled in demand mode, with the configured lead displayed in Wave Sector 1. If the configured lead is set to Pads, Lead II or the first available monitoring lead is displayed.

- 2 Change the pacer mode to fixed mode, using the menu selections shown below in Figure 54

**Figure 54 Changing Pacer Modes**

Main Menu
Pacer Mode
Volume
Displayed Waves
Printed Waves
Measurements/Alarms
Patient Info
Trends
Other
High Contrast On
Exit

Pacer Mode
Demand
Fixed

- 3 Use the Lead Select  button to select the desired lead for viewing.

**NOTE** If you want to see the ECG waveform and related parameters while pacing, you must have electrodes on the patient with pads. Using pads only will give you an incorrect heart rate and inappropriate alarms.

- 4 Press [**Pacer Rate**] and use the Navigation and Menu Select buttons to select the desired number of paced pulses per minute. The initial rate is configurable.
- 5 If needed, adjust the initial pacer output. To do this, press [**Pacer Output**] and use the Navigation and Menu Select buttons to select the desired output. The initial output is configurable.
- 6 Press [**Start Pacing**]. The message, **Pacing**, appears.

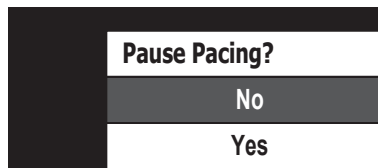
---

**WARNING** Use care when handling the multifunction electrode pads on the patient to avoid shock hazard during pacing.

---

- 7 Verify that white pacing markers appear on the ECG waveform.
- 8 Press [**Pacer Output**]. Then use the Navigation and Menu Select buttons to:
  - a. increase the output until cardiac capture occurs. Capture is indicated by the appearance of a QRS complex after each pace pulse marker.
  - b. decrease the output to the lowest level that still maintains capture.
- 9 Verify the presence of a peripheral pulse.
- 10 To pause or stop pacing:
  - Press [**Pause Pacing**].
  - A prompt message will ask you to confirm your action.

**Figure 55 Pause Pacing Message**



- Confirm your action. Use the Navigation buttons to highlight **Yes** and press the Menu Select button.
- OR
- Move the Therapy Knob off the **Pacer** position.

## Defibrillating During Pacing

Should it be necessary to defibrillate the patient during pacing, refer to the procedure for defibrillating in Manual Defib Mode in Chapter 6, or AED Mode in Chapter 5. Once the Therapy Knob is moved from the **Pacer** position to a Manual Defib Mode energy setting or **AED**, pacing is stopped.

To resume pacing after defibrillation, repeat the pacing procedure, as described in “Demand Mode Pacing” on page 88 or “Fixed Mode Pacing” on page 89. When pacing is resumed, pacing settings selected prior to defibrillation (mode, rate, and output) are retained. Be sure to confirm that cardiac capture has been maintained.

---

**CAUTION** Pacing must be turned off before defibrillating with a second defibrillator. Failure to do so could damage the HeartStart MRx.

---

## Troubleshooting

If your HeartStart MRx does not operate as expected during pacing, see Chapter 20, “Troubleshooting” on page 249.





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# Pulse Oximetry

Pulse Oximetry (SpO<sub>2</sub>) monitoring is one of the tools available to assist in assessing a patient's cardiac and respiratory systems. This chapter explains how pulse oximetry works and describes how to use the HeartStart MRx to monitor SpO<sub>2</sub>.

## Overview

Pulse oximetry is a noninvasive method of continuously measuring functional oxygen saturation (SpO<sub>2</sub>) in arterial blood. The resultant SpO<sub>2</sub> reading indicates the percentage of hemoglobin molecules in the arterial blood which are saturated with oxygen.

---

**WARNING** Do not rely solely on SpO<sub>2</sub> readings; assess the patient at all times. Inaccurate measurements can be caused by:

- Incorrect sensor application or use.
  - Significant levels of dysfunctional hemoglobins (such as carboxyhemoglobin or methemoglobin).
  - Injected dyes such as methylene blue, or intravascular dyshemoglobins such as methemoglobin or carboxyhemoglobin.
  - Exposure to excessive illumination such as surgical lamps (especially those with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, or direct sunlight.
- 

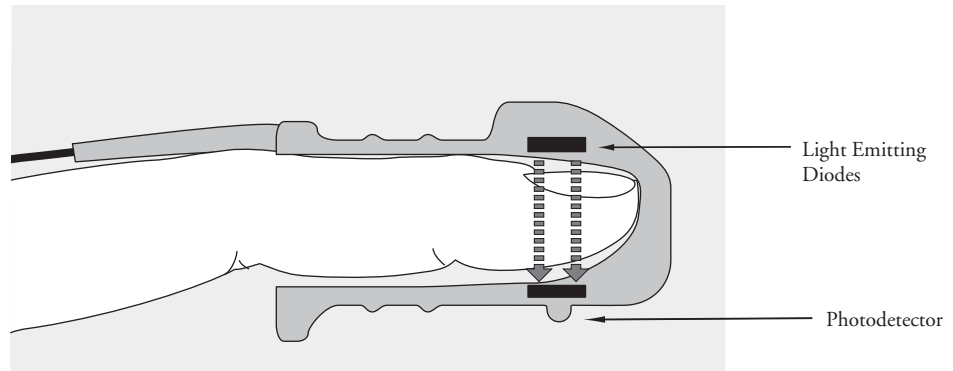
The HeartStart MRx allows you to monitor SpO<sub>2</sub> while in Monitor, Manual Defib, and Pacer modes. When using the Q-CPR option, SpO<sub>2</sub> monitoring functionality is not available.

**NOTE** For more information on SpO<sub>2</sub>, refer to the Application Note, *Philips Pulse Oximetry*.

## Understanding Pulse Oximetry

A pulse oximetry sensor sends light through patient tissue to a receiver on the other side of the sensor. As Figure 56 shows, light emitting diodes transmit red and infrared light through peripheral areas of the body, such as a finger.

**Figure 56 Pulse Oximetry Sensor**



A photodetector positioned opposite the light emitting diodes compares light absorption before and after pulsation. The amount of light getting through reflects the blood flow in the arterioles. This measurement of light absorption during pulsation is translated into an oxygen saturation percentage and an SpO<sub>2</sub> value is displayed.

For accurate SpO<sub>2</sub> measurements, the following conditions must apply:

- The patient must have perfusion in that extremity.
- The light emitter and the photodetector must be directly opposite each other.
- All of the light from the emitter must pass through the patient's tissue.
- The sensor site should be free of vibration and excessive motion.
- Power cables should be kept away from the sensor cable and connector.

## Selecting a Sensor

Table 9 shows the SpO<sub>2</sub> sensors that may be used with the HeartStart MRx.

**Table 9 SpO<sub>2</sub> Sensors**

Sensor	Type	Patient Type	Patient Size	Sensor Site
M1191A	Reusable	Adult	>50 kg	Finger
M1192A	Reusable	Pediatric Small Adult	15-50 kg	Finger
M1194A	Reusable	Adult Pediatric	>40 kg	Ear
M1195A	Reusable	Pediatric	4-15 kg	Finger
M1131A	Disposable	Adult/ Pediatric	> 20 kg	Finger
M1903B	Disposable	Pediatric	10-50 kg	Finger
M1904B	Disposable	Adult	> 30 kg	Finger

**NOTE** M1903B and M1904B sensors are only available outside the US.

- 
- CAUTION**
- Do not use disposable sensors in high humidity environments or in the presence of fluids which may contaminate sensor and electrical connections, causing unreliable or intermittent measurements.
  - Do not use disposable sensors on patients who have allergic reactions to the adhesive.
  - Do not use the ear transducer on patients with small ear lobes, as incorrect measurements may result.
- 

**NOTE** To use Nellcor<sup>®</sup> sensors (M1903B, M1904B), you must connect the M1943B Nellcor adapter cable to the HeartStart MRx.

The most important factor when selecting a sensor is the position of the light emitting diodes in relation to the photodetector. When a sensor is applied, the diodes and the photodetector must be opposite each other. Sensors are designed for patients with a specific weight range and for specific sites. Be sure to:

- Select a sensor appropriate for the patient's weight.
- Select a sensor site with adequate perfusion. Improve perfusion at the site by rubbing or warming the site.
- Avoid application to sites with edematous tissue.

**Reusable Sensors** may be reused on different patients after they have been cleaned and disinfected (see the manufacturer's instructions supplied with the sensor).

**Disposable Sensors** should be used only once and then discarded. They may be relocated to another sensor site on the patient if the first location does not give the desired results. Disposable sensors must not be reused on different patients.

**NOTE** A 2-meter SpO<sub>2</sub> extension cable (M1941A) is available for use with the HeartStart MRx.

## Applying the Sensor

Follow the manufacturer's directions for applying and using the sensor, making sure to observe any warnings or cautions. For the best results:

- Make sure the sensor is dry.
- If the patient is moving, secure the sensor cable loosely to the patient.
- Make sure the transducer is not too tight. Too much pressure can cause venous pulsation or can impede the blood flow, resulting in low readings.
- Keep power cables away from the sensor cable and connection.
- Avoid placing the sensor in an environment with bright lights. If necessary, cover the sensor with opaque material.
- Avoid placing the sensor on an extremity with an arterial catheter, blood pressure cuff, or intravenous infusion line.

- 
- WARNING**
- Failure to apply the sensor properly may reduce the accuracy of the SpO<sub>2</sub> measurement.
  - Inspect the sensor application site at least every two hours for changes in skin quality, correct optical alignment, and proper sensor application. If skin quality is compromised, change the sensor site. Change the application site at least every four hours. More frequent checking may be required due to an individual patient's condition.
  - Using an SpO<sub>2</sub> sensor during MR imaging can cause severe burns. Minimize this risk by positioning the cable so that no inductive loops are formed. If the sensor does not appear to be operating properly, remove it immediately from the patient.
- 

- 
- CAUTION** Do not use more than one extension cable (M1941A).  
Position the sensor cable and connector away from power cables to avoid electrical interference.
-

## Monitoring SpO<sub>2</sub>

To monitor SpO<sub>2</sub>:

- 1 Connect the appropriate sensor cable to the to the HeartStart MRx as described in “Connecting the SpO<sub>2</sub> Cable” on page 36.
- 2 Apply the sensor to the patient.
- 3 If the HeartStart MRx is not turned on, turn the Therapy Knob to **Monitor**.
- 4 Check that the patient category is appropriate for the patient. If necessary, use the **Patient Info** menu to access **Patient Category** and select the correct patient category setting (adult/pediatric). This is used to optimize the calculation of the SpO<sub>2</sub> and pulse values.

A **·?·** is displayed in Parameter Block 2 while the oxygen saturation is initially measured and a value is calculated. In a few seconds a value appears, replacing the **·?·**. As the patient’s oxygen saturation changes, the SpO<sub>2</sub> value is updated continuously. See Figure 57.

If SpO<sub>2</sub> alarms are turned on, alarm limits are displayed to the right of the SpO<sub>2</sub> value. If alarms are turned off, the **⊗** symbol is displayed instead of the alarm limits. SpO<sub>2</sub> alarms are on by default. See “SpO<sub>2</sub> Alarms” on page 100.

The patient’s pulse rate as derived from pulse oximetry, is displayed in Parameter Block 1 (see Figure 59). If pulse rate alarms are turned on, alarm limits are displayed to the right of the pulse rate value. If alarms are turned off, the **⊗** symbol is displayed instead of the alarm limits. Pulse alarms are off by default. See “Pulse Rate Alarms” on page 101.

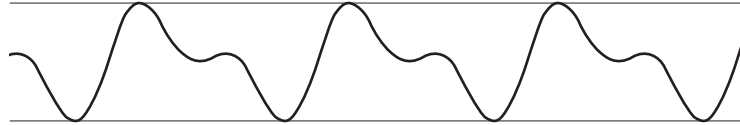
**Figure 57 SpO<sub>2</sub> Parameter Block 2**

ABP	mmHg	PAP	mmHg	SpO <sub>2</sub>	%	EtCO <sub>2</sub>	mmHg	AwRR	rpm
118/77	SYS	24/10	DIA	100	100	38	50	18	30
(95)	160	(15)	16		90	30			8
	90		0						

## Pleth Wave

When the sensor is connected to the HeartStart MRx, the pleth wave is displayed in the configured Wave Sector or the first available empty Wave Sector. It is drawn at an approximate speed of 25 mm/second. Grid lines are displayed to indicate signal quality. When signal quality is good, the pleth wave is auto scaled to the grid lines. When signal quality is poor, the size of the pleth wave is proportionately decreased.

**Figure 58 Pleth Wave Size**



When the Therapy Knob is moved to an energy setting, the SpO<sub>2</sub> values and pleth wave continue to be displayed as long as they are not located in Wave Sector 2 or you're in Q-CPR View. When the Therapy Knob is moved to **Pacer**, the pacing status bar appears in Wave Sector 4, replacing the waveform in that sector. If the pleth wave was removed, the SpO<sub>2</sub> and Pulse values and alarm settings are retained. If the Therapy Knob is moved to **AED**, SpO<sub>2</sub> and pulse related information is no longer monitored.

## SpO<sub>2</sub> Alarms

Alarms are annunciated if measurements fall outside the configured limits for high or low SpO<sub>2</sub>, or if the measurement falls below the configured SpO<sub>2</sub> Desat Limit. SpO<sub>2</sub> alarms are all categorized as “non-latching” alarms, meaning they are automatically removed when their alarm condition no longer exists. Table 10 lists SpO<sub>2</sub> alarms.

**Table 10 SpO<sub>2</sub> Red/Yellow Physiological Alarms**

Alarm Message	Type of Alarm	Indicator	Condition
Desat	Red	Red alarm message; alarm tone	The SpO <sub>2</sub> value has fallen below the desat low limit.
SpO <sub>2</sub> High	Yellow	Yellow alarm message; alarm tone	The SpO <sub>2</sub> value exceeds the high alarm limit.
SpO <sub>2</sub> Low	Yellow	Yellow alarm message; alarm tone	The SpO <sub>2</sub> has dropped below the low alarm limit.

SpO<sub>2</sub> alarms are on unless you turn SpO<sub>2</sub> alarms off or alarms for the entire device are off. Once disabled, alarms remain off until they are turned on.


---

**WARNING** Turning off alarms prevents all alarms associated with the SpO<sub>2</sub> measurement from being annunciated. If an alarm condition occurs, NO alarm indication will be given.

---

## Changing the SpO<sub>2</sub> Alarm Limits

To change the SpO<sub>2</sub> high and low alarm limits, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **SpO<sub>2</sub>** and press the Menu Select button.
- 4 Select **SpO<sub>2</sub> Limits** and press the Menu Select button.
- 5 Using the Navigation buttons, select the new high limit value and press the Menu Select button.
- 6 Select the new low limit value and press the Menu Select button.




## SpO<sub>2</sub> Desat Alarm

The HeartStart MRx also provides an alarm for SpO<sub>2</sub> Desat Limit. The SpO<sub>2</sub> Desat alarm provides an additional limit setting below the low limit setting to notify you of potentially life threatening decreases in oxygen saturation. This additional limit setting is preset through the **Configuration** menu.

**NOTE** If the SpO<sub>2</sub> Low Limit alarm value is set below the configured SpO<sub>2</sub> Desat Limit, the SpO<sub>2</sub> Desat Limit value is automatically adjusted to the SpO<sub>2</sub> Low Limit alarm value. Should the SpO<sub>2</sub> reading fall below this limit, the SpO<sub>2</sub> Desat Limit alarm is announced.

## Enabling/Disabling the SpO<sub>2</sub> Alarms

To enable the SpO<sub>2</sub> Alarms, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **SpO<sub>2</sub>** and press the Menu Select button.
- 4 Select **Alarms On/Off** and press the Menu Select button.

**NOTE** While an NBP measurement is in progress, SpO<sub>2</sub> INOP messages are suppressed for up to 60 seconds.

## Pulse Rate Alarms


Pulse Rate alarms are off unless you enable them during use. The configured alarm limits may be changed during use. Alarms are annunciated if measurements fall outside the configured limits for high and low pulse rate. Pulse Rate alarms are all categorized as “non-latching” alarms, meaning they are automatically removed when their alarm condition no longer exists. Table 11 details Pulse Rate alarms.

**Table 11 Pulse Rate Physiological Alarms**

Alarm Message	Type of Alarm	Indicator	Condition
Pulse High	Yellow	Yellow alarm message; alarm tone	Pulse value exceeds the high alarm limit.
Pulse Low	Yellow	Yellow alarm message; alarm tone	Pulse value has fallen below the low alarm limit.


## Enabling/Disabling the Pulse Rate Alarms

To enable/disable the Pulse Rate Alarms, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **Pulse** and press the Menu Select button.
- 4 Select **Alarms On/Off** and press the Menu Select button.

## Changing the Pulse Rate Alarm Limits

To change the Pulse Rate Alarm Limits, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **Pulse** and press the Menu Select button.
- 4 Select **Pulse Limits** and press the Menu Select button.
- 5 Using the Navigation buttons, select the new high limit value and press the Menu Select button.
- 6 Select the new low limit value and press the Menu Select button.

## Disabling the SpO<sub>2</sub> Monitoring Function

To disable the SpO<sub>2</sub> monitoring function, disconnect the sensor cable from the SpO<sub>2</sub> port. The message **SpO2 Unplugged. Turn off SpO2?** appears. Select **Yes** and press the Menu Select button.

Should the sensor cable be disconnected accidentally, the message **SpO2 Unplugged. Turn off SpO2?** appears to notify you of the disconnection. Select **No** and press the Menu Select button. Secure the connection. The SpO<sub>2</sub> monitoring function is once again enabled.

## Caring for Sensors

Refer to the manufacturer's instructions for care and cleaning of sensors. To get the best results from your reusable SpO<sub>2</sub> sensors, always handle the sensor and cable with care and protect them from sharp objects. The sensor sleeve houses a sensitive electronic device that can be damaged. Harsh treatment of sensors will drastically reduce their lifetime.

---

**WARNING** Do not use a damaged sensor or one with exposed electrical circuits.

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## Troubleshooting

If your HeartStart MRx does not operate as expected during SpO<sub>2</sub> Monitoring, see Chapter 20, "Troubleshooting" on page 249.



# Noninvasive Blood Pressure

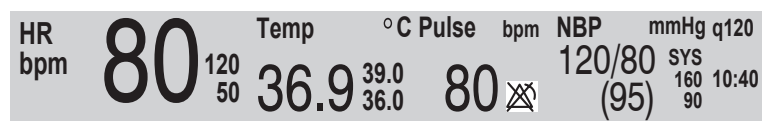
This chapter describes how to monitor noninvasive blood pressure (NBP) with the HeartStart MRx.

## Overview

Your HeartStart MRx measures blood pressure for both adult and pediatric patients using the oscillometric method. Systolic, diastolic, and mean measurements are provided, and alarms are available to alert you to changes in the patient's condition. NBP measurements may be taken while in Monitor, Pacer, or Manual Defib modes. NBP measurements can be taken automatically on a schedule or manually on demand.

While an NBP measurement is in progress, the current cuff pressure is displayed in Parameter Block 1. Once the measurement is complete, the values for systolic, diastolic, and mean pressure are displayed, along with the measurement schedule (manual or automatic intervals) and a time stamp (see Figure 59). If NBP alarms are enabled, alarm limits appear next to the NBP value and the alarm source (systolic, diastolic, or mean) is displayed above the NBP alarm limits. If alarms are off, the alarms off symbol  $\otimes$  replaces the limits.

**Figure 59** NBP / Parameter Block 1



For more information on monitoring NBP, refer to the Application Note, *About Noninvasive Blood Pressure*.

---

**WARNING** Do not perform NBP monitoring on patients whose upper arm circumference is less than 13 cm. Doing so may result in inaccurate measurements.

---

The first time an NBP measurement is taken, the cuff's initial inflation pressure is 160 mmHg (adult) or 120 mmHg (pediatric). If the measurement is successful, the next inflation pressure is 35-40 mmHg above the systolic measurement, with a minimum inflation pressure of 120 mmHg. If the patient's systolic pressure measurement is higher than the inflation pressure, the cuff inflation pressure is automatically increased by 35-40 mmHg and another measurement is attempted. The maximum cuff inflation pressure is 280 mmHg, while the maximum systolic value is 260 mmHg.

---

**WARNING** Initial cuff inflation pressure is based on the configured patient type, adult or pediatric. If necessary, select the correct patient type during use by changing the Patient Category selection through the Patient Info menu.

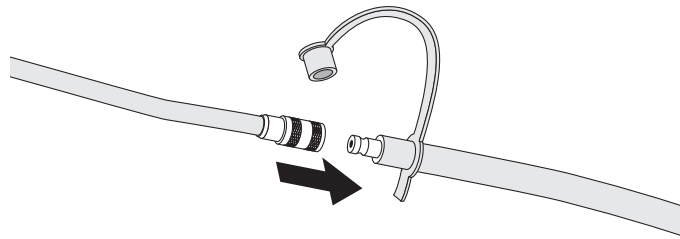
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## Preparing to Measure NBP

To prepare for NBP measurement:

- 1 Select the appropriately sized cuff for the patient. The cuff width should be either 40% of the limb circumference or  $2/3$  of the upper arm length. The inflatable part of the cuff should be long enough to encircle 50%-80% of the limb. The wrong cuff size may give false and misleading results. If you do not have the correct cuff size, use a larger one to minimize error.
- 2 Attach the cuff to the NBP tubing, making sure that air can pass through the tubing and that the tubing is not squeezed or kinked (see Figure 60).

**Figure 60** Connecting the NBP Cuff/Tubing



- 3 Insert the NBP tubing into the NBP port as described in “Connecting the NBP Interconnect Tubing” on page 37.

- 4 Apply the blood pressure cuff to the patient's arm or leg as follows:
  - a. Ensure that the cuff is completely deflated.
  - b. The cuff should not be placed on the same extremity as an SpO<sub>2</sub> sensor. Wrap the cuff around the arm, making sure that the artery marker is aligned over the brachial artery. Ensure that the cuff is not wrapped too tightly around the limb. Excessive tightness may cause discoloration and eventual ischemia of the extremities. Also ensure that the NBP tubing from the defibrillator to the cuff is not compressed, crimped, or damaged.
  - c. Check that the edge of the cuff falls within the range identified by the <---> markings. If it does not, use a larger or smaller cuff that fits better.
- 5 Place the limb used for taking the measurement at the same level as the patient's heart.

- 
- WARNING**
- Do not perform noninvasive blood pressure measurements on patients with sickle-cell disease or any condition where skin damage has occurred or is expected.
  - Do not use in a hyperbaric chamber.
  - Use clinical judgement to decide whether or not to perform automatic blood pressure measurements on patients with severe blood clotting disorders, because of the risk of hematoma in the limb wearing the cuff.
  - Do not apply the cuff to a limb that has an intravenous infusion or catheter in place. This could cause tissue damage around the catheter when the infusion is slowed or blocked during cuff inflation.
  - Use only approved cuffs and tubing in order to prevent inaccurate data, injury, or damage. All specified cuffs are protected against the effects of the discharge of a defibrillator.
  - Prolonged series of noninvasive blood pressure measurements in automatic mode may be associated with purpura, ischemia, and neuropathy in the limb wearing the cuff. When monitoring a patient, examine the extremities of the limb frequently for normal color, warmth, and sensitivity. If any abnormality is observed, stop the blood pressure measurements immediately.
  - Blood pressure readings may be affected by the position of the subject, his/her physiologic condition, the presence of arrhythmia, and other factors.
  - To obtain accurate blood pressure readings, the cuff must be the correct size and also be correctly fitted to the patient. Incorrect size or incorrect fitting may result in incorrect readings.
- 

- CAUTION**
- Do not compress or restrict pressure tubes during an NBP measurement.
  - If a spill occurs and liquid appears to be inside the tubing, contact your service personnel.
- 

**NOTE** When using the HeartStart MRx aboard aircraft, NBP measurements should only be taken while on the ground or once cruising altitude is reached. Measurements taken during ascent or descent may not be accurate.

## Measuring NBP

To measure NBP, press the **[Start NBP]** soft key. The cuff pressure is displayed as the cuff inflates and deflates. When the measurement is complete, the NBP values are displayed. Additional measurements are taken according to the configured NBP schedule. If the schedule is configured to:

**Manual** - There is no schedule for additional measurements. One measurement is taken each time you press **[Start NBP]**. Take additional measurements by pressing **[Start NBP]**.


**Automatic** - The measurement is repeated at the configured interval of 1, 2.5, 5, 10, 15, 30, 60, or 120 minutes from the time you press the **[Start NBP]** soft key. Additional manual measurements may be taken without affecting the automatic measurement schedule, by pressing **[Start NBP]**.

The configured NBP schedule may be changed during use through the **Measurements/Alarms** menu. If the automatic measurement schedule is changed, the new time interval is applied to the start time of the last measurement. If the new time interval is less than or the same as the time since the last measurement, a measurement begins immediately.

**NOTE** You may perform a manual NBP measurement at any time, even when an automatic schedule is set. Simply press the **[Start NBP]** soft key. To stop an NBP reading in progress, press the **[Stop NBP]** soft key.

## Changing the NBP Schedule

To change the NBP schedule and/or the interval of automatic measurements for the current patient:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **NBP** and press the Menu Select button.
- 4 Select **NBP Schedule** and press the Menu Select button.
- 5 Using the Navigation buttons, select the desired interval and press the Menu Select button.

**NOTE** Interval choices are presented in the format “qx”, indicating measurements will be taken every “x” minutes from the time you first press **[Start NBP]**.

**NOTE** If no subsequent measurements are taken, NBP values will be removed from the display after 60 minutes but can still be obtained through Vital Signs Trending.



## Alarms

An NBP alarm is annunciated when a measurement for the configured source (systolic, diastolic, or mean) falls outside the configured high or low limits. NBP alarms are all categorized as “non-latching” alarms, meaning they are automatically removed when their alarm condition no longer exists. Both the source of the alarm and the limits may be changed during use, for the current patient incident. NBP alarms are on unless you disable them. Once disabled, alarms remain off until enabled. Table 12 lists NBP alarms.

**Table 12 NBP Red/Yellow Physiological Alarms**

Alarm Message	Type of Alarm	Indicator	Condition
NBPs High	Yellow	Yellow alarm message; alarm tone	The NBP systolic value exceeds the high alarm limit.
NBPd High	Yellow	Yellow alarm message; alarm tone	The NBP diastolic value exceeds the high alarm limit.
NBPm High	Yellow	Yellow alarm message; alarm tone	The NBP mean value exceeds the high alarm limit.
NBPs Low	Yellow	Yellow alarm message; alarm tone	The NBP systolic value has fallen below the low alarm limit.
NBPd Low	Yellow	Yellow alarm message; alarm tone	The NBP diastolic value has fallen below the low alarm limit.
NBPm Low	Yellow	Yellow alarm message; alarm tone	The NBP mean value has fallen below the low alarm limit.


---

**WARNING** Turning off alarms prevents all alarms associated with the NBP measurement from being annunciated. If an alarm condition occurs, NO alarm indication will be given.

---


## Changing NBP Alarms

To change the NBP alarm source and/or limits for the current patient incident:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **NBP** and press the Menu Select button.
- 4 Select **NBP Limits** and press the Menu Select button.
- 5 Select the desired source for the alarm, **Systolic**, **Diastolic**, or **Mean**, and press the Menu Select button.
- 6 Using the Navigation buttons, increase or decrease the high limit value and press the Menu Select button.
- 7 Set the new low limit value and press the Menu Select button.

## Enabling/Disabling NBP Alarms

To enable/disable NBP Alarms:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **NBP** and press the Menu Select button.
- 4 Select **Alarms On/Off** and press the Menu Select button.

## Troubleshooting

If your HeartStart MRx does not operate as expected during NBP Monitoring, see Chapter 20, “Troubleshooting” on page 249.

---

# Monitoring Carbon Dioxide

This chapter describes how to monitor carbon dioxide (CO<sub>2</sub>) and measure end-tidal carbon dioxide (EtCO<sub>2</sub>) and Airway Respiration Rate (AwRR) with the HeartStart MRx using the Microstream<sup>®</sup> (sidestream) method. CO<sub>2</sub> Monitoring is available in Monitor, Pacer, and Manual Defib modes.

## Overview

The carbon dioxide monitoring function of the HeartStart MRx, together with the appropriate FilterLine<sup>®</sup> and, if necessary, airway adapter, measures the partial pressure of carbon dioxide in a sample of the patient's exhaled breath aspirated from the breathing circuit. The HeartStart MRx may be used to monitor carbon dioxide in both intubated and non-intubated patients.

The partial pressure of carbon dioxide is derived by multiplying the measured carbon dioxide concentration with the ambient pressure. From the partial pressure measurement, the end-tidal carbon dioxide (EtCO<sub>2</sub>) is derived. EtCO<sub>2</sub> is the peak CO<sub>2</sub> value measured during expiration. It is used to monitor the patient's respiratory status. The EtCO<sub>2</sub> measurement uses a technique based on the absorption of infrared radiation by some gases. It indicates the change in:

- The elimination of CO<sub>2</sub>.
- The delivery of O<sub>2</sub> to the lungs.

The CO<sub>2</sub> monitoring function of the HeartStart MRx provides an EtCO<sub>2</sub> value, a CO<sub>2</sub> waveform, and an airway respiration rate (AwRR).

---

**WARNING** The EtCO<sub>2</sub> readings do not always correlate closely with blood gas values, especially in patients with pulmonary disease, pulmonary embolism or inappropriate ventilation.

Do not measure CO<sub>2</sub> in the presence of pharmaceuticals in aerosols.

---

**NOTE** For more information on capnography and EtCO<sub>2</sub>, refer to the Application Note, *Uses of Capnography and Benefits of the Microstream Method*.

# Preparing to Measure EtCO<sub>2</sub>

## Selecting the Accessories

There are some factors to consider when selecting accessories:

- the type of patient, adult, pediatric, or neonate.
- airway status of the patient, ventilated or not ventilated.
- if a ventilated patient, whether humidified or non-humidified ventilation is used.

---

**WARNING** Do not re-use, clean, or sterilize Microstream CO<sub>2</sub> accessories as they are intended for single-patient, one-time use.

---

Table 13 shows CO<sub>2</sub> accessories with their corresponding application areas.

**Table 13 Microstream CO<sub>2</sub> Accessories**

Part Number	Circuit	Description
M1920A	Intubated	FilterLine Set - Adult/Pediatric 25 sets/case
M1921A	Intubated	FilterLine H Set - Adult/Pediatric 25 sets/case
M1923A	Intubated	FilterLine H Set - Infant/Neonatal yellow, 25 sets/case
M2520A	Non-Intubated Dual Purpose	Smart CapnoLine™- Pediatric
M2522A	Non-Intubated Dual Purpose	Smart CapnoLine - Adult
M2524A	Non-Intubated Single Purpose	Smart CapnoLine - Pediatric
M2526A	Non-Intubated Single Purpose	Smart CapnoLine - Adult

---

**WARNING** Use only Microstream accessories (as listed above) to ensure correct functioning of the CO<sub>2</sub> sidestream measurement.

---



---

**WARNING** Due to a measurement delay, do not use Microstream (sidestream) CO<sub>2</sub> as a direct reference for determining the end expiratory point in the pressure curve.

---

**NOTE** The HeartStart MRx is equipped with automatic barometric pressure compensation.

# Setting Up Microstream EtCO<sub>2</sub> Measurements

- WARNING**
- Danger - explosion hazard - sidestream measurement should not be used in the presence of flammable anesthetics such as:
    - flammable anesthetic mixture with air
    - flammable anesthetic mixture with oxygen or nitrous oxide
  - CO<sub>2</sub> should not be measured in the presence of aerosolized pharmaceuticals.
  - When using the nasal FilterLine, if one or both nostrils are partially or completely blocked, or the patient is breathing through the mouth, the displayed EtCO<sub>2</sub> values may be significantly low.
  - Reflux of gastric contents, mucus, pulmonary edema fluid or endotracheal epinephrine introduced into the detector can increase airway resistance and affect ventilation. Discard accessory if this occurs.
  - The presence of carbonated beverage or antacids in the stomach may cause incorrect readings and unreliable capnography in identifying esophageal intubation.

## Using the Nasal FilterLine

To set up EtCO<sub>2</sub> measurements using the nasal FilterLine, perform the following steps:

- 1 Attach the FilterLine tubing to the CO<sub>2</sub> Inlet port as described in “Connecting the CO<sub>2</sub> FilterLine” on page 40.
- 2 Check that both nostrils are clear and position the nasal FilterLine on the face by inserting the FilterLine tips into the nostrils.
- 3 Pass the FilterLine tubing over the ears, then slide the sleeve up the tubing towards the neck to a comfortable fit under the chin. If using dual purpose FilterLine tubing, connect the green tubing to the oxygen source. Check the positioning of the FilterLine regularly to ensure proper monitoring function.
- 4 Change the nasal FilterLine every 24 hours, if the **CO2 Occlusion** INOP message appears, or if measurement readings become erratic.

## Using the FilterLine and Airway Adapter

To set up EtCO<sub>2</sub> measurements using the FilterLine and airway adapter:

- 1 Attach the FilterLine tubing to the CO<sub>2</sub> Inlet port as described in “Connecting the CO<sub>2</sub> FilterLine” on page 40.
- 2 Connect the wide end of the airway adapter to the endotracheal tube and connect the narrow end of the airway adapter to the ventilator tubing or manual resuscitator.

Disconnect the FilterLine during suctioning and nebulizing therapies. For best results for non-humidified use, change the FilterLine after 24 hours of continuous use. For humidified use, change the FilterLine H after 72 hours of continuous use.

**WARNING** When using the Microstream EtCO<sub>2</sub> measurement on patients who are receiving or have recently received anesthetics, connect exhaust tubing from the CO<sub>2</sub> Outlet port to a scavenging system or to the anesthesia machine/ventilator to prevent exposing medical staff to anesthetics. Use an exhaust tube to remove the sample gas to a scavenging system. Attach scavenging tube to the CO<sub>2</sub> outlet port.

**NOTE** Should the FilterLine or exhaust tubing be blocked when the HeartStart MRx is turned on, the **CO2 Check Exhaust INOP** message is displayed. Should the blockage occur during CO<sub>2</sub> monitoring, the CO<sub>2</sub> waveform appears as a flat line, and if alarms are on, an apnea alarm is annunciated.

## Measuring EtCO<sub>2</sub>

The EtCO<sub>2</sub> measurement is automatically turned on when you connect a FilterLine to the CO<sub>2</sub> Inlet port. The CO<sub>2</sub> waveform is displayed in the configured Wave Sector if available. The measurement values for EtCO<sub>2</sub> and AwRR are displayed in Parameter Block 2 (see Figure 61).

Figure 61 EtCO<sub>2</sub> and AwRR / Parameter Block 2

ABP	mmHg	PAP	mmHg	SpO2	%	EtCO2	mmHg	AwRR	rpm
118/77	SYS	24/10	DIA	100	100	38	50	18	30
(95)	160	(15)	16	90	90	30	30	8	8

## EtCO<sub>2</sub> and AwRR Alarms

Alarms are annunciated if measurements fall outside the configured limits for high or low EtCO<sub>2</sub>, high or low Airway Respiration Rate (AwRR) and Apnea time. EtCO<sub>2</sub> alarms are all categorized as “non-latching” alarms, meaning they are automatically removed when their alarm condition no longer exists.

Table 14 EtCO<sub>2</sub> Red/Yellow Physiological Alarms


Alarm Message	Alarm Type	Indicator	Condition
Apnea	Red	Red alarm message; alarm tone	No detectable breaths for the configured number of seconds.
EtCO <sub>2</sub> High	Yellow	Yellow alarm message; alarm tone	The EtCO <sub>2</sub> value exceeds the high alarm limit.
EtCO <sub>2</sub> Low	Yellow	Yellow alarm message; alarm tone	The EtCO <sub>2</sub> value has fallen below the low alarm limit
AwRR High	Yellow	Yellow alarm message; alarm tone	The AwRR value exceeds the high alarm limit.
AwRR Low	Yellow	Yellow alarm message; alarm tone	The AwRR value has fallen below the low alarm limit.

EtCO<sub>2</sub> and AwRR alarms are on unless you turn them off or alarms for the entire device are off. Once disabled, alarms remain off until they are turned back on.

**WARNING** Turning off alarms prevents all alarms associated with EtCO<sub>2</sub> or AwRR measurements from annunciating. If an alarm condition occurs, NO alarm indication will be given.


## Changing the EtCO<sub>2</sub> Alarm Limits

To change the EtCO<sub>2</sub> alarm limits:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **EtCO<sub>2</sub>** and press the Menu Select button.
- 4 Select **EtCO<sub>2</sub> Limits** and press the Menu Select button.
- 5 Using the Navigation buttons, increase or decrease the high limit value and press the Menu Select button.
- 6 Set the new low limit value and press the Menu Select button.


## Enabling/Disabling the EtCO<sub>2</sub> Alarms

To enable or disable the EtCO<sub>2</sub> alarms:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **EtCO<sub>2</sub>** and press the Menu Select button.
- 4 Select **Alarms On/Off** and press the Menu Select button.


## Changing the AwRR Alarm Limits

To change the AwRR alarm limits:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **AwRR** and press the Menu Select button.
- 4 Select **AwRR Limits** and press the Menu Select button.
- 5 Using the Navigation Buttons, increase or decrease the high limit value and press the Menu Select button.
- 6 Set the new low limit value and press the Menu Select button.


## Changing the Apnea Time Alarm Limit

To change the apnea time alarm limit:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **AwRR** and press the Menu Select button.
- 4 Select **Apnea Time** and press the Menu Select button.
- 5 Using the Navigation buttons, increase or decrease the limit and press the Menu Select button.

## Enabling/Disabling AwRR Alarms

To enable the AwRR alarms:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select **AwRR** and press the Menu Select button.
- 4 Select **Alarms On/Off** and press the Menu Select button.

- 
- WARNING**
- The safety and effectiveness of the respiration measurement method in the detection of apnea, particularly the apnea of infancy, has not been established.
  - The selected apnea alarm may be delayed by up to 17 seconds, if apnea occurs during the automatic zero process.
- 

## Disabling the EtCO<sub>2</sub> Monitoring Function

To disable the EtCO<sub>2</sub> monitoring function, disconnect the FilterLine from the CO<sub>2</sub> inlet port. The message **CO2 Unplugged. Turn off EtCO2?** appears. Select **Yes** and press the Menu Select button.

Should the FilterLine be disconnected accidentally, the message **CO2 Unplugged. Turn off EtCO2?** appears to notify you of the disconnection. Select **No** and press the Menu Select button. Secure the connection. The CO<sub>2</sub> monitoring function is once again enabled.

## Troubleshooting

If your HeartStart MRx does not operate as expected during CO<sub>2</sub> Monitoring, see Chapter 20, “Troubleshooting” on page 249.



---

# Invasive Pressures

This chapter describes how to monitor invasive pressures using the HeartStart MRx.

## Overview

The Invasive Pressures option on your HeartStart MRx offers two channels of real-time continuous invasive pressure measurements and waveforms in Monitor, Manual Defib and Pacer modes. If the pressure signal is pulsatile, numeric values are displayed for systolic, diastolic and mean pressure. If the pressure signal is non-pulsatile, then only the mean is displayed. Alarms are provided to alert you to a change in the patient's condition. If alarms are enabled, alarm limits appear next to the pressure value and the alarm source is displayed above the alarm limits. If alarms are off, the Alarms Off symbol replaces the limits.

## Setting up for a Pressure Measurement

- 1 Turn the HeartStart MRx on.
- 2 Connect the pressure cable to the HeartStart MRx.

**NOTE** The HeartStart MRx will perform a check of invasive pressure functionality when the option is turned on.

- 3 Connect the cable to the transducer.
- 4 Prepare the flush solution.
- 5 Flush the system to expel air from the tubing. Make sure the stopcocks and transducer are also free of air bubbles.

---

**WARNING** If air bubbles appear in the tubing system, flush the system with infusion solution again. Air bubbles may lead to an incorrect reading.

---

- 6 Connect the pressure line to the patient catheter.

- 7 If you are using an infusion pressure cuff with the pressure line, attach the pressure cuff to the fluid to be infused. Inflate it according to your hospital's standard procedure then begin the infusion. Position the transducer so that it is level with the heart, approximately at the level of the midaxillary line.

---


**WARNING** If measuring intracranial pressure (ICP) with a sitting patient, level the transducer with the top of the patient's ear. Incorrect leveling may lead to an incorrect reading.

---

## Selecting a Pressure to Monitor

You need to assign a label to each pressure channel as it is connected. Channels are identified as Press 1 and Press 2. You can apply labels to each pressure channel by selecting the appropriate pressure label using the Menu Select button. Once you select a label, the HeartStart MRx will use that label's stored information (color, alarm source and limits, scale) as the default. You should check each pressure channel label as the cable is connected and make changes as appropriate.

To select a pressure label, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select **Press 1** (or **Press 2**) and press the Menu Select button.
- 4 Select **Label** and press the Menu Select button.
- 5 Select the appropriate label from the list provided (see Table 15 for list) and press the Menu Select button.
- 6 Select the size of your scale (See "Pressure Waves" on page 120).
- 7 Select Alarm Source type (See "Alarms" on page 127).
- 8 Set the high and low alarm limits.

Repeat the steps to label the other pressure channel.

**NOTE** Changing the pressure site label activates scales and alarm settings associated with the new label. You will be presented with the controls for scale and alarm settings after selecting a label from the menu to either confirm or adjust the value. Table 15 lists pressure labels.

**Table 15 Pressure Labels**

Label	Description	Label	Description
ABP	Arterial Blood Pressure	LAP	Left Atrial Pressure
ART	Arterial Blood Pressure	PAP	Pulmonary Artery Pressure
Ao	Aortic Pressure	RAP	Right Atrial Pressure
CVP	Central Venous Pressure	P1	Non-specific pressure label (Channel 1)
ICP	Intracranial Pressure*	P2	Non-specific pressure label (Channel 2)

\* - Cerebral Perfusion Pressure (CPP) is automatically displayed with ICP when one pressure is already set to ABP, ART or Ao and the other pressure is set to ICP. CPP will be displayed in the same color as ICP. Only one of the ICP or CPP alarms can be enabled at the same time. See Alarms page 127.


**NOTE** When selecting a pressure label for a pressure channel, the label assigned to the other pressure channel appears in your options list only if the other channel is not connected to a transducer. If you select the same label as the other channel, the label for the other channel changes to a non-specific label (P1 or P2). If you decide to re-label the first channel, the other channel's label remains non-specific (P1 or P2).

**NOTE** To monitor a pressure from an arterial waveform when using an intra-aortic balloon pump, connect your invasive pressure device directly to the balloon pump.

## Pressure Waves

Each pressure label has a set of scales for the pressure wave. You can adapt the displayed wave to the offset and amplitude of the signal. The scale can be modified through the **Displayed Waves** menu.

To select a pressure wave and the associated scale for the display or printed strip, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, highlight **Displayed Waves** and press the Menu Select button.
- 3 Select Wave Position (**Wave 1**, **Wave 2**, **Wave 3** or **Wave 4**) and press the Menu Select button.
- 4 Select the appropriate label and press the Menu Select button.
- 5 Select the appropriate scale and press the Menu Select button.

Available scales in mmHg:

300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, -5, -10, -15, and -20.

Available scales in kPa:

38.0, 32.0, 26.0, 24.0, 22.0, 20.0, 18.0, 16.0, 14.0, 13.0, 12.0, 11.0, 10.0, 9.0, 8.0, 7.0, 6.0, 5.0, 4.0, 3.0, 2.0, -1.0, -1.5, -2.0, -2.5.

**NOTE** A positive scale sets the top gridline to your selected scale and the bottom to zero. A negative scale will set the bottom gridline to the selected negative unit and the middle gridline to zero.

# Zeroing the Pressure Transducer

To avoid inaccurate pressure readings, the HeartStart MRx requires a valid zero be performed on the pressure channel. It should be zeroed according to your hospital policy - at least once per day. Also, you should rezero in the following circumstances:

- Every time you reconnect the transducer cable to the HeartStart MRx.
- After a patient is moved.
- During changes in altitude when using the HeartStart MRx aboard an aircraft. Re-zero when reaching a cruising altitude.
- When you use a new transducer or tubing.
- When you think the pressure readings are not correct.

**NOTE** The numeric value will be invalid (displayed as ·?·) when the transducer is plugged in until zeroed successfully.

For each assigned label, the pressure channel can be zeroed through the Menu Select button menu or, when in Monitor Mode, through the use of a soft key. You can zero the pressure channels separately or together.


---

**WARNING** Before zeroing a pressure, make sure related pressure transducers are vented to atmospheric pressure and the stopcock to the patient is closed.

---

## Zeroing Using the Menu Select Button

To Zero using the Menu Select button, perform the following:

- 1 Place the transducer at the appropriate level for the measurement site.
- 2 Close the transducer stopcock to the patient and vent the transducer to atmospheric pressure.
- 3 On the HeartStart MRx, press the Menu Select  button.
- 4 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 5 Select the pressure label you wish to perform the zero procedure on.
- 6 Press **Zero** and press the Menu Select button. Zeroing begins.

## Zeroing Using a Soft Key in Monitor Mode

To Zero using the soft key in Monitor Mode, perform the following:

- 1 Place the transducer at the appropriate level for the measurement site.
- 2 Close the transducer stopcock to the patient and vent the transducer to atmospheric pressure.
- 3 Press the button under **[Zero Pressure]** on the display.
- 4 Using the Navigation buttons, select the pressure(s) you wish to zero from the **Zero** menu and press the Menu Select button. Zeroing begins.

**WARNING** Invasive pressure alarms and pulse alarms (if they are derived from invasive pressure readings) are temporarily turned off while the transducer is zeroing. The alarms will turn back on 30 seconds after zeroing is complete.

During the zeroing process, a message will appear on the HeartStart MRx display. If the process was successful, the message on the screen changes to **Pressure label zero done at date/time** (for example: ABP zero done at 25Jan2006, 9:26). If the process is unsuccessful, you get an **Unable to zero** message with a probable cause message displayed. Table 16 lists probable cause messages.

**Table 16 Unable to Zero Probable Causes:**

Probable Cause Message	Corrective Action
Equipment Malfunction	Hardware is faulty. Contact your service personnel.
Excessive Offset	Make sure the transducer is vented to the air and try again. If this doesn't work, replace the transducer cable and try again. If it still doesn't zero, replace the transducer and try again. If it still will not zero, contact your service personnel.
Unstable Signal	
No Transducer	Reconfirm that the transducer is connected and try again. If this doesn't work, replace the transducer.
Pulsatile Pressure	Make sure that the transducer is vented to air and not the patient. Try again.


**NOTE** Upon successful completion of the process, close the stopcock to atmospheric pressure, which opens the stopcock to the patient.

# Calibration

The HeartStart MRx allows you to input the calibration factor (see documentation supplied by the transducer's manufacturer) of a new transducer plugged into the pressure line.

## Known Calibration Factor

To set a known calibration factor, perform the following:

- 1 Zero the transducer (see previous section)
- 2 Press the Menu Select  button.
- 3 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 4 Select the correct pressure (**channel: label**) and press the Menu Select button.
- 5 Select **Calibration Factor** and press the Menu Select button.
- 6 Set the calibration factor using the Navigation buttons. Values range from 180.0 to 220.0 in 0.2 increments. Press the Menu Select button.

**NOTE** Calibration only needs to be done on reusable transducers.

## Calibrating Reusable Transducer CPJ840J6

Perform a mercury calibration when you use a new reusable transducer and at regular intervals according to your hospital policy. You will need:

- standard sphygmomanometer
- sterile 10cc syringe with heparinized solution
- 3-way stopcock
- approximately 25cm of tubing.

---

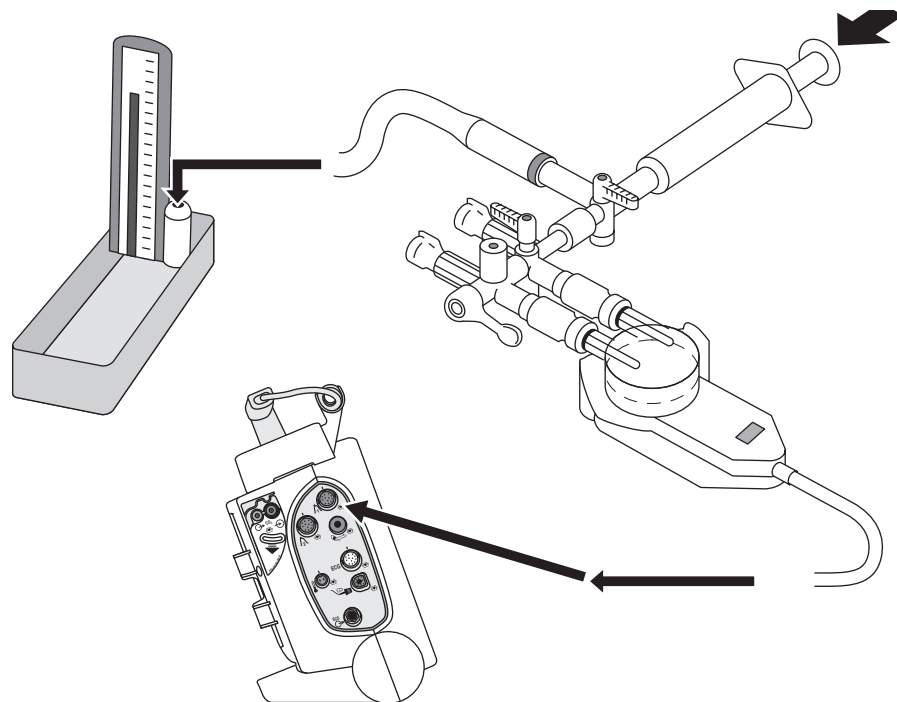
**WARNING** Never perform invasive pressure mercury calibration while the patient is being monitored.

---


To perform a mercury calibration on the CPJ840J6, perform the following:

- 1 Zero the transducer (see previous section).
- 2 Connect the syringe and manometer. (See Figure 62.)
  - a. Attach the tubing to the manometer
  - b. Connect the 3-way stopcock to the stopcock that is not connected to the patient catheter.
  - c. Attach the syringe to one port and the manometer to the other port.
  - d. Open the port to the manometer

**Figure 62** Connecting the Syringe and Manometer





- 3 Raise the manometer pressure to approximately 200 mmHg or 27.0 kPa.
- 4 Press the Menu Select  button.
- 5 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 6 Select the pressure (**channel: label**) you wish to calibrate and press the Menu Select button.
- 7 Select **Calibration Pressure** and press the Menu Select button.
- 8 Using the Navigation Buttons, select the **Calibration Pressure** you set for the manometer in Step 3 above. The default is 200 mmHg (27.0 kPa). Values range from 90 to 220 mmHg in increments of 1 (12.0 to 30.0 kPa in increments of 0.2).
- 9 Press the Menu Select button. The HeartStart MRx will automatically set and display the calibration factor.

**NOTE** Upon successful calibration, write the calibration factor on the transducer for future reference.

## Calibration Confirmation

If the calibration process is successful, a brief message appears on the HeartStart MRx display with the date and time the calibration was completed and the new calibration factor. If calibration is not successful, an **Unable to Calibrate** message appears with a probable cause. See Table 17 for probable cause messages.

**Table 17 Unable to Calibrate Probable Causes**

Message	Corrective Action
Equipment Malfunction	Hardware is faulty. Contact your service personnel.
Out of range	Make sure you have selected a value for the calibration pressure that you are applying to the transducer. Repeat calibration.
Unstable Signal	Make sure there are no disturbances to the transducer. Repeat calibration.
No Transducer	Reconfirm that the transducer is connected and try again.
Perform Zero first	A valid zero does not exist. Zero the transducer.

---


**WARNING** Each time you use a reusable transducer, you should confirm the calibration factor written on the transducer is the same as the calibration factor displayed on your HeartStart MRx. Different calibration factors may lead to an inaccurate measurement.

---

## Last Zero/Calibration

You can view dates and times for a channel's last zero or mercury calibration through the HeartStart MRx menu.

To view a channel's last zero and mercury calibration dates, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select the pressure label (**channel: label**) you want and press the Menu Select button.
- 4 The last zero and Mercury calibration dates and times are displayed.

**NOTE** The information listed for the last mercury calibration is the date and time of either calibrating at a known pressure or entering the calibration factor manually.

**Figure 63 Last Zero and Mercury Calibration Dates**

<b>Press 1: ABP</b> <b>Last Zero 28 Nov 2005 09:05</b> <b>Last Mercury Cal 28 Nov 2005 09:06</b>	
	<b>Label</b>
	<b>Zero ABP</b>
	<b>Calibration Pressure</b>
	<b>Calibration Factor</b>
	<b>Alarms Off</b>
	<b>ABP Limits</b>
	<b>Exit</b>

## Non-Physiological Artifact Suppression


Various clinical procedures (i.e. taking a blood sample) may affect invasive pressure readings. Your HeartStart MRx can be configured to suppress alarms when artifact is detected for a specific length of time. You can configure suppression lengths in Configuration Mode. Options are 30, 60 and 90 seconds or off. The default is 60 seconds. During suppression, the HeartStart MRx shows an INOP message and ? next to the pressure label. Pressure alarms and **Pressure Label Non-Pulsatile** INOPs are inactive during the suppressed period. The CPP high alarm is not suppressed.

# Alarms

Alarms are provided to alert you to a change in the patient's condition. If alarms are enabled, alarm limits appear next to the pressure value. Invasive pressure alarms are all categorized as “non-latching” alarms, meaning they are automatically removed when their alarm condition no longer exists. Table 18 details invasive pressure alarms.

**Table 18 Invasive Pressure Red/Yellow Physiological Alarms**

Alarm Message	Type of Alarm	Indicator	Condition
[ABP, ART, Ao, PAP, P1, P2] Disconnect	Red	Red alarm message; alarm tone	The mean pressure has fallen below 10 mmHg (1.3 kPa) and the pressure is non-pulsatile.
[Pressure label]s High	Yellow	Yellow alarm message; alarm tone	The systolic pressure value exceeds the high alarm limit.
[Pressure label]d High	Yellow	Yellow alarm message; alarm tone	The diastolic pressure value exceeds the high alarm limit.
[Pressure label]m High	Yellow	Yellow alarm message; alarm tone	The mean pressure value exceeds the high alarm limit.
[Pressure label]s Low	Yellow	Yellow alarm message; alarm tone	The systolic pressure value has fallen below the low alarm limit.
[Pressure label]d Low	Yellow	Yellow alarm message; alarm tone	The diastolic pressure value has fallen below the low alarm limit.
[Pressure label]m Low	Yellow	Yellow alarm message; alarm tone	The mean pressure value has fallen below the low alarm limit.

Each pressure label has its own unique set of default alarm limits which are set in Configuration mode. See “Configuration” on page 181 for details. If the alarm is from a pulsatile source, the source is displayed above the alarm limits. If alarms are off, the Alarms Off  symbol replaces the limits.

If a wave becomes non-pulsatile, the measurement will become mean only and be compared to the current source (which may be systolic or diastolic) and alarm limits.


---

**WARNING** Make sure you enable/disable and set alarm limits for the correct label. These settings apply to that particular label only. Changing the label might change the alarm limits.

---

## Enabling/Disabling alarms


To enable/disable alarms, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select the pressure label (**channel: label**) you wish to modify alarm status on and press the Menu Select button.
- 4 Select **Alarms On** (or **Alarms Off**) and press the Menu Select button.


## Viewing/Changing/Setting Source for Alarms

Alarm sources and limits can be viewed or modified for a given pressure label.

To view or modify alarm settings, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select the pressure label (**channel: label**) you wish to view/modify alarms on and press the Menu Select button.
- 4 Select pressure label **Limits** and press the Menu Select button.
- 5 If the pressure label is pulsatile, select the desired source of the alarm (Systolic, Diastolic or Mean) and press the Menu Select button.
- 6 Using the Navigation buttons, increase or decrease the high limit and press the Menu Select button.
- 7 Set the new low limit and press the Menu Select button.

## CPP Alarms

With CPP and ICP, only one of the two parameters can have alarms enabled at one time. If CPP alarms are turned on then ICP alarms are turned off. Both alarms can be turned off at the same time. The parameter with alarms off will be displayed at the bottom of the ICP/ CPP parameter area with the Alarms Off  symbol. ICP alarms default to on; CPP to off.

## Wedge

Perform a pulmonary artery wedge procedure according to your hospital protocol. The wedge numeric will not be stored in the Vital Signs Trending.

---

**WARNING** For Pulmonary Artery Wedge Pressure (PAWP) readings, due to a measurement delay, do not use Microstream (sidestream) CO<sub>2</sub> as a direct reference for determining the end expiratory point in the pressure curve.

If the pulmonary artery flotation catheter drifts into the wedge position without inflation of the balloon, the pulmonary artery pressure waveform will assume a wedged appearance. To correct the situation take appropriate action in accordance with standard procedures.

---

# Pulse

The HeartStart MRx can provide pulse readings from either the SpO<sub>2</sub> or Invasive Pressures options. To understand how pulse works with SpO<sub>2</sub> only, read Chapter 8, Pulse Oximetry. If your device has both options, read the following section.

## Pulse Sources


When both SpO<sub>2</sub> and Invasive Pressures options are present on the HeartStart MRx, pulse can be derived from an SpO<sub>2</sub> pleth wave or one of the two invasive pressure waves in Monitor, Pacing and Manual Defib modes. The pulse reading will be displayed in the color of its source (e.g. if your pleth wave is cyan and pulse is being derived from the pleth wave, then the pulse reading will appear in cyan.)

Pulse is on (and displayed) if one of the possible sources is activated. SpO<sub>2</sub> is the factory default but can be modified in Configuration Mode. If the default pulse source is not active during an event but a secondary source is, the pulse value will appear on screen but it will be invalid and display a **·?·** where the value should be. A **Pulse Check Source** INOP will also appear on the screen. To obtain a pulse rate, you must modify the pulse source to an active source for this incident.

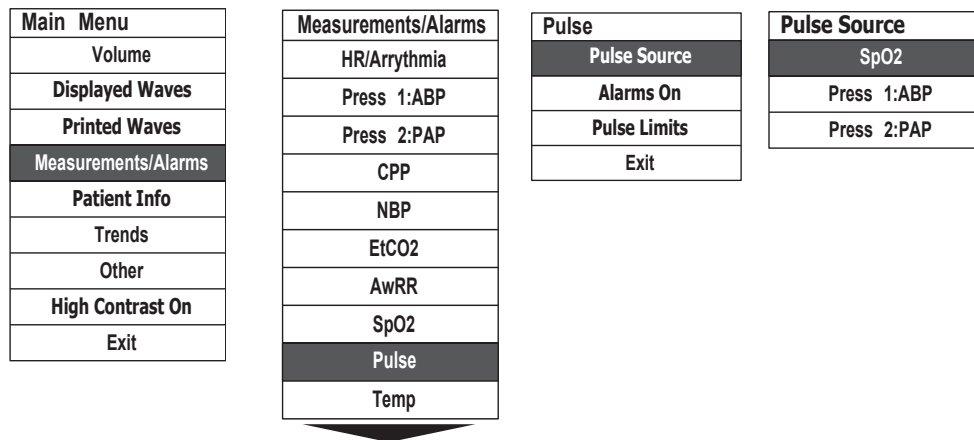
If the pulse source you are using to obtain a pulse rate is disconnected during active measuring and a secondary pulse source is available, the pulse rate does not automatically switch to the secondary source. The pulse value (and the value of your source measurement) remains on screen but becomes invalid and displays a **·?·** where the value should be. An INOP message also appears on screen. To reactivate a pulse reading, reconnect the original pulse source or change the pulse source to the secondary option.

## Changing Pulse Source

To change pulse source for the current incident, perform the following steps:


- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select **Pulse** and press the Menu Select button.
- 4 Select **Pulse Source** and press the Menu Select button. Pick a source with an arterial or pulmonary waveform.
- 5 Using the Navigation buttons, highlight the pulse source desired and press the Menu Select button.

**Figure 64 Pulse Source**




## Setting Pulse Alarms

When on, pulse alarms annunciate if measurements fall outside of the limits for high or low pulse. Alarms are turned off unless you turn them on during use. Once turned on, alarms remain on until they are turned back off.

**NOTE** If pulse alarms are enabled, alarm limits appear next to the pulse value. If alarms are off the Alarms Off  symbol replaces the limits.

## Enabling/Disabling Pulse Alarms


Pulse alarms are turned off by default. To turn the pulse alarms on for the current incident perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select **Pulse** and press the Menu Select button.
- 4 Select **Alarms On** and press the Menu Select button.

The alarms will now be on. To turn alarms off, repeat the steps above except select **Alarms Off** in Step 4.

## Pulse Alarm Limits

Pulse alarm limits can be changed for the current incident. To change alarm limits, perform the following steps:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select **Pulse** and press the Menu Select button.
- 4 Select **Pulse Limits** and press the Menu Select button.
- 5 Using the Navigation buttons, select the new high limit value and press the Menu Select button.
- 6 Select the new low limit and press the Menu Select button.

## Changing Default Pulse Source and Alarm Limits

You can change the default pulse source in the pulse section of Configuration Mode. See Chapter 17. Because pulse and heart rate share the same default alarm limits, default pulse alarm limits can be changed in the ECG section of Configuration Mode.

## Caring For Your Transducers and Probes

Refer to the manufacturer's instructions for care and cleaning of your invasive pressure transducers and cables. Inappropriate treatment of the cables will reduce their lifetime.

## Troubleshooting

If your HeartStart MRx does not operate as expected during invasive pressure monitoring, see Chapter 20 "Troubleshooting".



# Temperature

This chapter describes how to monitor temperature using the HeartStart MRx.

## Overview

The HeartStart MRx offers one channel of real-time continuous temperature monitoring. The device can monitor nasopharyngeal, esophageal, rectal, skin, arterial, venous, core and urinary bladder temperatures. Measurements, which can be displayed in either Fahrenheit or Celsius, may be taken while in Monitor, Pacer or Manual Defib modes.


## Selecting a Temperature Label

The HeartStart MRx monitors the temperature of the area where the sensor is located. To assure specific temperature settings are matched with the temperature reading, assign the proper temperature label to the measurement. When modifying a temperature label, all settings (including alarm limits) associated with that label become active. The default label is Temp.

**Table 19 Temperature Labels**

Label	Type	Label	Type
Tesoph	esophageal temperature	Tnaso	nasopharyngeal temperature
Trect	rectal temperature	Tvesic	urinary bladder
Tskin	skin temperature	Tart	arterial temperature
Temp	non-specific temp label	Tven	venous temperature
Tcore	core temperature		

To select a temperature label, perform the following:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select the temperature label option currently assigned to your measurement (default is **Temp**) and press the Menu Select button.
- 4 Select **Label** and press the Menu Select button.
- 5 Select the appropriate label from the list provided and press the Menu Select button.

# Monitoring Temperature

To monitor temperature, perform the following:

- 1 Connect the temperature cable to the HeartStart MRx.
- 2 Select the correct temperature label for your measurement.
- 3 Check that the current device settings (including alarm settings) are appropriate for the patient.
- 4 Apply the temperature probe to the patient.

**NOTE** The temperature function performs a self-test when initially turned on and also performs hourly system tests when active.

## Alarms

### Setting Temperature Alarms

Temperature alarms are annunciated if measurements fall outside the configured limits for high and low temperatures. Temperature alarms are all categorized as “non-latching” alarms, meaning they are automatically removed when their alarm condition no longer exists. Table 20 details Temperature alarms.

**Table 20 Temperature Physiological Alarms**


Alarm Message	Type of Alarm	Indicator	Condition
[Temperature label] High	Yellow	Yellow alarm message; alarm tone	The temperature value exceeds the high alarm limit.
[Temperature label] Low	Yellow	Yellow alarm message; alarm tone	The temperature value has fallen below the low alarm limit.

Alarms are on unless you turn them off during use. Once turned off, alarms remain off until they are turned back on.

---


**WARNING** Make sure you enable/disable and set alarm limits for the correct label. These settings are stored for that particular label only. Changing the label may change the alarm limits.

---

**NOTE** If temperature alarms are enabled, alarm limits appear next to the temperature value. If alarms are off the Alarms Off  symbol replaces the limits.


## Changing Temperature Alarm Limits

To change the temperature alarm limits for the current incident, perform the following:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
- 3 Select the temperature label option currently assigned to your measurement and press the Menu Select button.
- 4 Select **Temperature Limits** and press the Menu Select button.
- 5 Using the Navigation buttons, change the high limit and press the Menu Select button.
- 6 Using the Navigation buttons, change the low limit and press the Menu Select button.

## Enabling/Disabling Temperature Alarms

Temperature alarms default to on. To disable temperature alarms, perform the following:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select the **Measurements/Alarms** menu and press the Menu Select button.
- 3 Select the temperature label option currently assigned to your measurement and press the Menu Select button.
- 4 Select **Alarms Off** and press the Menu Select button.

To turn alarms back on, repeat the steps above except select **Alarms On** in Step 4.

## Changing Degree Units

The HeartStart MRx can display temperature in either Fahrenheit or Celsius. The default is Celsius and can only be changed through Configuration Mode. See Chapter 17 for more information.

## Disabling the Temperature Function

To turn off the Temperature function, disconnect the temperature cable from the HeartStart MRx port. The message **Temp** (or the label currently activated) **unplugged. Turn off Temp?** appears. Select **Yes** and press the Menu Select button.

Should the temperature cable get disconnected accidentally or if the probe and cable separate, the message **Temp unplugged. Turn off Temp?** appears to notify you of the disconnection. To continue monitoring temperature, select **No** and press the Menu Select button. Reconnect the temperature cable to restart the temperature monitoring function. See “Turning Parameters On/Off” on page 18.

## Caring For Your Temperature Cables and Probes

Refer to the manufacturer’s instructions for care and cleaning of your cables. Inappropriate treatment of the cables will reduce their lifetime.

## Troubleshooting

If your HeartStart MRx does not operate as expected during temperature monitoring, see Chapter 20, “Troubleshooting”.

---

# 12-Lead ECG

This chapter describes how to use the diagnostic 12-lead ECG function of the HeartStart MRx.

## Overview

The optional 12-lead ECG function is available in Monitor Mode and allows you to preview, acquire, print, copy, and store a 12-lead ECG. In addition, the 12-lead function provides computerized ECG analysis, using the Philips 12-Lead Algorithm. A report with measurements and interpretive statements from the analysis is displayed, stored and printed, as configured.

The Philips 12-Lead Algorithm provides an analysis of the amplitudes, durations, and morphologies of the ECG waveforms and the associated rhythm. The algorithm is age/gender specific and very dependent on the patient's paced status. Patient age and gender are used to define normal limits for heart rate, axis deviation, time intervals, and voltage values, for interpretation accuracy in tachycardia, bradycardia, prolongation or shortening of PR and QT intervals, hypertrophy, early repolarization, and myocardial infarction. Adult criteria apply if the patient age is 16 years old or older. Pediatric criteria apply if the patient age is less than 16.

---

**WARNING** Computerized ECG interpretation is not intended to be a substitute for interpretation by a qualified physician.

---

**NOTE** For information on the Philips 12-Lead Algorithm, see *The Philips 12-Lead Algorithm Physician's Guide*, available at <http://www.medical.philips.com/main/products/resuscitation>, under "Documentation and Downloads." The HeartStart MRx offers only the "Non-paced" and "Paced" Pacing Detection Settings, with Non-paced the default setting.

**NOTE** For information related to the standard IEC 60601-2-51 please go to [www.medical.philips.com/goto/productdocumentation](http://www.medical.philips.com/goto/productdocumentation).

## Preview Screen

The 12-lead function's Preview Screen allows you to see real-time 12-lead ECG data and verify signal quality before acquiring the ECG. As shown in Figure 65, it displays patient information and approximately 2.5 seconds of each of the 12 leads acquired. Waveforms are presented at a rate of 25mm/sec and the configured wave size. A dashed line is displayed if a lead cannot be derived. The message **(Lead-Wire) Lead Off** is displayed if an electrode is not making adequate contact with the patient.

The Preview Screen's patient information includes ID, age, and sex. The Event ID is displayed until you enter the patient's ID. Age and sex are displayed once entered (see "Entering Patient Information" on page 27).

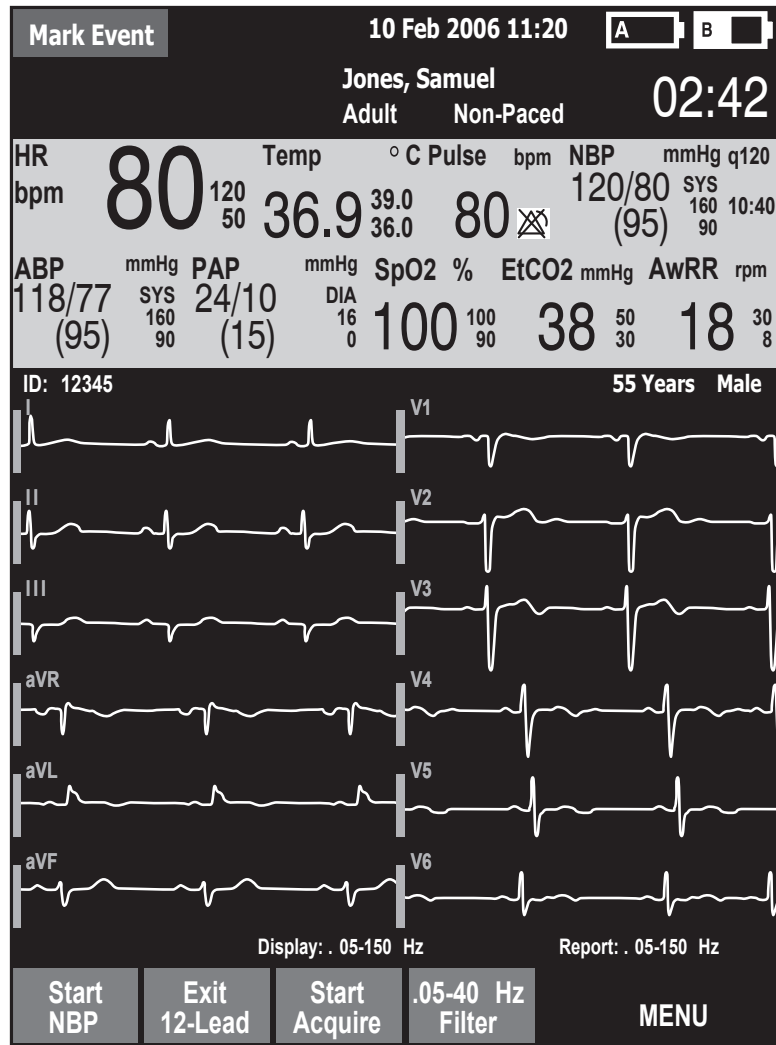
Although waveforms for monitored parameters such as ECG, SpO<sub>2</sub>, Invasive Pressures and CO<sub>2</sub> are not visible on the Preview Screen, related alarms, measurements and INOP messages remain active and are reported in Parameter Blocks 1 and 2 and the general status area.

## Preparation

Proper patient preparation and electrode placement are the most important elements in producing a high quality 12-lead ECG. The patient should be supine and relaxed when an ECG is acquired. In preparation for acquiring the ECG:


- 1 Connect the 10-lead cable to the HeartStart MRx, as described in "Connecting the ECG Cable" on page 35.
- 2 Prepare the patient and apply electrodes, as described in "Preparing to Monitor ECG" on page 49.
- 3 Turn the Therapy Knob to **Monitor**.
- 4 Enter the patient's ID, name, age and sex as described in "Entering Patient Information" on page 27.
- 5 Confirm the patient's pacing status is correct.

Figure 65 12-Lead ECG Preview Screen



## Acquiring the 12-Lead ECG

Once preparation is complete, to acquire a 12-lead ECG in Monitor Mode:

- 1 Press the [**12-Lead**] soft key.  
The Preview Screen is displayed, as shown in Figure 65.
- 2 Check the signal quality on each lead and, if necessary, make adjustments as described in “Improving Signal Quality” on page 143.
- 3 Check filter settings.
- 4 Press the [**Start Acquire**] soft key. The message **Acquiring 12-Lead** is then displayed while the HeartStart MRx acquires ten seconds of ECG data.
- 5 If patient age and sex were not previously entered, you are prompted to enter the information.
  - a. For age, use the Navigation buttons to increase or decrease the displayed value of the patient’s age. Then press the Menu Select button .
  - b. For sex, use the Navigation buttons to select the patient’s sex and press the Menu Select button.
- 6 Keep the patient still while the message **Acquiring 12-Lead** is displayed.

Once ECG acquisition is complete, ECG analysis begins automatically and is accompanied by the message **Analyzing 12-Lead**. The patient does not need to be still during this time.


Following analysis, the 12-Lead Report is displayed, printed, and stored internally.

To acquire another 12-Lead ECG, press [**New 12-Lead**]. To exit the 12-lead function, press [**Exit 12-Lead**].

---

**WARNING** Failure to enter correct patient age, sex and pacing status can result in erroneous diagnosis.

---

**NOTE** The Lead Select  button is disabled when the 12-lead function is active.



# 12-Lead Report

The 12-Lead Report View is in a format similar to Monitor View, so that you may monitor the patient while viewing the report. In this view, the 12-Lead Report replaces Monitoring View's Wave Sectors 3 and 4, as shown in Figure 66, and includes the following information, if configured:

**Measurements** - The measurements component of the algorithm generates standard interval and duration measurements, in milliseconds, limb lead axis measurements, in degrees, and heart rate, in beats per minute.

**Interpretive statements** - Measurements and patient information (age, gender, paced status) are used by the Philips 12-Lead Algorithm to generate statements describing the patient's cardiac rhythm and waveform morphology. Statements regarding signal quality problems encountered during ECG acquisition are also included in this section.

**ECG severity** - Each interpretive statement on the report has an associated severity. The severities of all selected interpretive statements are assessed to determine an overall severity for the ECG. The categories of severity are "**No Severity**," "**Normal ECG**," "**Otherwise Normal ECG**," "**Borderline ECG**," "**Abnormal ECG**," and "**Defective ECG**."

Stored and printed 12-Lead Reports can be configured to include all 12 leads, measurements, and interpretive analysis statements.

One or two copies of the 12-Lead Report are printed at the completion of acquisition and/or analysis, as configured. Press the **[Print]** soft key to print another copy. In addition to the information on the displayed 12-Lead Report, the printed report includes up to three rhythm strips, with the configured leads.

- 
- WARNING**
- Should an alarm condition occur while a 12-Lead Report is printing, an alarm strip is not printed, however, the corresponding ECG waveform is stored and available in the Event Summary.
  - Do not pull on the paper while a report is being printed. This can cause distortion of the waveform and lead to potential misdiagnosis.
- 

## Accessing Stored Reports

You may access stored reports to print additional copies or delete the report from internal storage. You may also copy the report to a data card. The list of stored reports for the current patient event may be accessed while a report is displayed or from either the 12-Lead Acquire Screen or the 12-Lead Preview Screen. To do this:


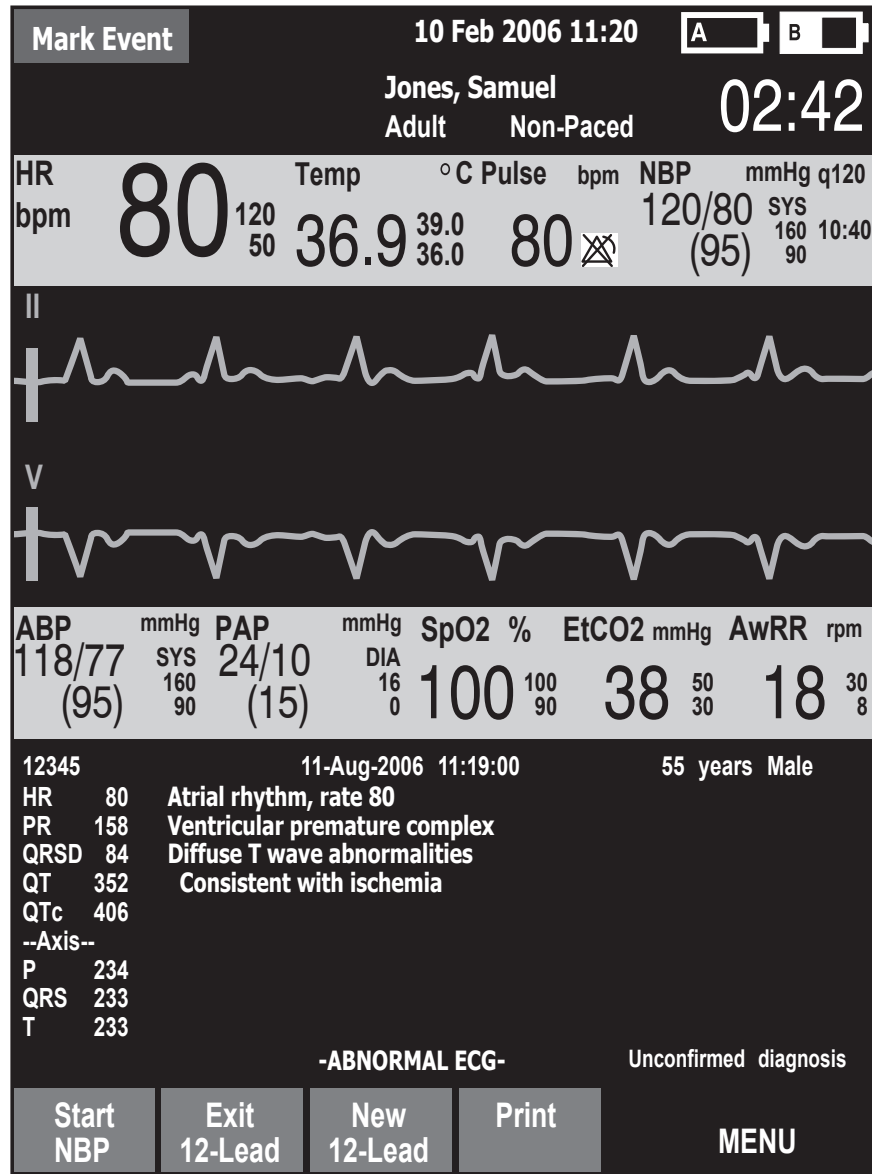
- 1 While in 12-Lead, press the Menu Select  button.
- 2 Using the Navigation buttons, select **Reports**.  
Reports for the current patient event are listed by date, time and sequence number.
- 3 Use the Navigation buttons to select a report and press the Menu Select button.
- 4 Select **Print**, **Copy**, or **Delete** and press the Menu Select button.
- 5 To select another report repeat steps 1 through 3, or press **Exit** to close the menu.


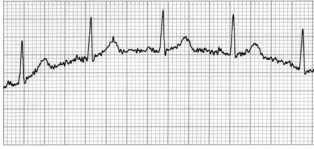
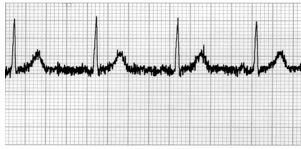

Figure 66 Displayed Report



# Improving Signal Quality


Signal quality can impact ECG analysis. Refer to Table 21 for possible solutions to common ECG quality problems.

**Table 21 ECG Signal Problems**

Problem	Possible Causes	Possible Solutions
Tremor or muscle artifact 	<ul style="list-style-type: none"> <li>Poor electrode placement.</li> <li>A cold patient.</li> <li>Tense, uncomfortable patient.</li> <li>Patient tremors.</li> </ul>	<ul style="list-style-type: none"> <li>Clean the site and reapply electrodes. Be sure the electrodes are placed on flat, non-muscular areas of the body.</li> <li>Warm the patient.</li> <li>Reassure and relax the patient.</li> <li>Attach electrodes high on the extremities, near the trunk.</li> </ul>
Baseline wander 	<ul style="list-style-type: none"> <li>Patient movement</li> <li>Electrode movement. Poor electrode contact and skin preparation.</li> <li>Respiratory interference.</li> </ul>	<ul style="list-style-type: none"> <li>Reassure and relax the patient.</li> <li>Be sure lead wires are not pulling on the electrodes.</li> <li>Move electrodes away from areas with the greatest respiratory motion, if possible.</li> </ul>
Power line AC Interference 	<ul style="list-style-type: none"> <li>Poor electrode contact. Dry or dirty electrodes.</li> <li>Interference from poorly grounded instrument near patient.</li> </ul>	<ul style="list-style-type: none"> <li>Reapply electrodes.</li> <li>Route electrode wires along the limbs and away from other electrical equipment.</li> </ul>
Intermittent or jittery waveform 	<ul style="list-style-type: none"> <li>Poor electrode contact.</li> <li>Dry electrodes.</li> <li>Faulty lead wires</li> </ul>	<ul style="list-style-type: none"> <li>Clean the site and reapply electrodes.</li> <li>Apply new electrodes.</li> <li>Repair or replace faulty leads.</li> </ul>

## Adjusting Wave Size

Adjusting ECG wave size may improve signal visibility. To do this:

- 1 While in 12-Lead, press the Menu Select  button.
- 2 Using the Navigation buttons, select **ECG Size** and press the Menu Select button.
- 3 Using the Navigation buttons, select the desired size value and press the Menu Select button.

The lead size is retained when you exit and then return to 12-lead functionality, without turning off power for more than 10 seconds.

**NOTE** Selecting ECG wave size of either **10mm/mV ½ V** or **20 mm/mV ½ V** displays V leads at half of the selection, 5 mm/mV and 10 mm/mV, respectively.

## 12-Lead Filters

ECG bandwidth filters of 0.15 - 40 Hz, 0.05 - 40 Hz, or 0.05 - 150 Hz may be selected in Configuration to apply to 12-lead ECG waveforms shown on the display. Additionally, the 12-Lead Report may be configured to apply either the same filter choice used for the display, or a 0.05 - 150 Hz filter. The filter setting for the 12-Lead Report is applied to both printed and stored 12-Lead Reports.

**NOTE** Although, the 0.05 -150 Hz, or "Diagnostic" bandwidth filter may be selected for the display filter, LCD display limitations prevent the ECG from appearing in true diagnostic quality.

A filter soft key is available to switch between filter settings during use. When changing the filter during use, the filter setting is applied to both the display and the 12-Lead Report. The display and 12-Lead Report filter settings are returned to their configured settings whenever the [**New 12-Lead**] soft key is pressed or when the Therapy Knob is moved from the **Monitor** position.

## Troubleshooting

If your HeartStart MRx does not operate as expected during 12-Lead ECG operation, see Chapter 20, "Troubleshooting" on page 249.

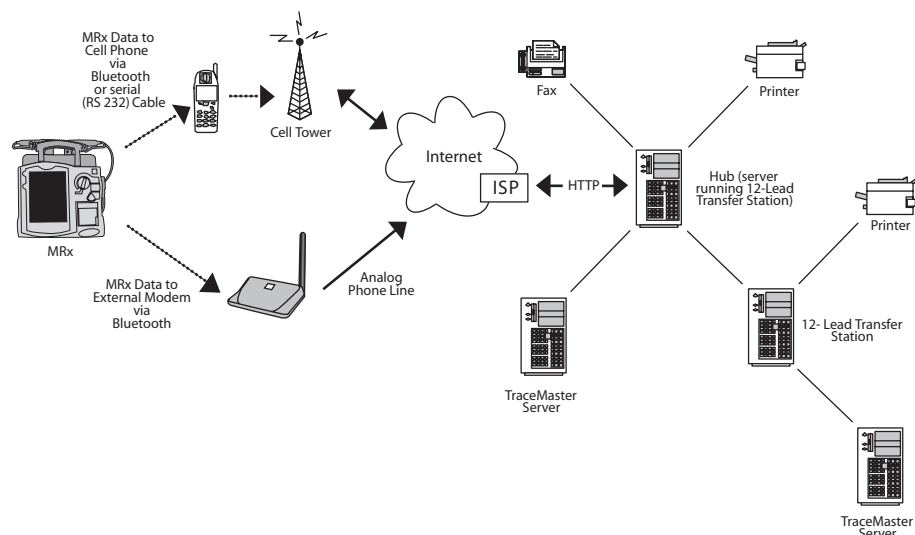
# 12-Lead ECG Transmission

This chapter provides instructions for the transmission of 12-Lead Reports from the HeartStart MRx using wireless Bluetooth technology or its RS 232 Serial Port.

## Overview

12-Lead reports may be transmitted to printers, fax machines, Philips TraceMaster ECG Management System or other servers running Philips 12-Lead Transfer Station software. Reports are sent from the HeartStart MRx to the hub (a web server running Philips 12-Lead Transfer Station software). Using Bluetooth transmission, they are transmitted to the hub using configured wireless devices such as cell phones and handheld devices. Using RS 232 Transmission, they are transmitted via a cell phone with internet capability connected to the MRx's RS 232 Serial Port. The 12-Lead Transfer Station then forwards the report to the selected destination site. Additionally, reports can be sent to a wireless modem connected to an analog line for areas where cell transmission is unavailable. See Figure 67 for an overview of the transmission process.

**Figure 67 12-Lead Report Transmission Process**



Waveforms for all monitored parameters can be viewed during the 12-Lead Report transmission process, however, the waveform appearing in Wave Sector 4 is partially obscured when the transmission status bar is displayed. Related alarms, measurements and INOP messages remain active and are reported in Parameter Blocks 1 and 2 and the general status area.

---

**CAUTION** Data transmission via cell phone can sometimes be unreliable. A strong signal and stationary transmission will improve the transmittal success rate. Follow the directions provided with your cell phone.

---

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**CAUTION** Many institutions prohibit the use of cell phones on their premises. Please abide by local rules and regulations.

---

**NOTE** Patient Name and ID must be entered prior to 12-Lead acquisition in order for it to appear on the 12-Lead Report.

**NOTE** The .05 - 40 Hz 12-Lead filter setting is supported by TraceMasterVue version A.02.01 or higher.

## Setting Up for Bluetooth Transmission

12-Lead ECG Transmission using Bluetooth<sup>®</sup> requires the configuration and set up of wireless devices that will send the 12-Lead Report to the hub.


**NOTE** For further information concerning the setup and configuration of transmission devices and the HeartStart MRx, refer to the *12-Lead Transmission Implementation Guide*. For further information concerning the 12-Lead Transfer Station, refer to the *12-Lead Transfer Station Instructions for Use*.

### Adding a Bluetooth Device

Up to 20 Bluetooth devices may be configured for use. Adding a twenty-first device replaces the device used least recently.

**NOTE** Bluetooth devices may not be added or modified during 12-Lead transmission. Conversely, 12-Lead transmission is not allowed during Bluetooth device configuration.

To add a Bluetooth device to the list of Transmission Devices:

- 1 Once in 12-Lead mode, press the Menu Select  button.
- 2 Using the Navigation buttons, select **Bluetooth Devices** and press the Menu Select button. A list of discovered Bluetooth devices is displayed.
- 3 Select **Add Device** and press the Menu Select button. The message **Searching for Bluetooth Devices** is displayed.
- 4 From the Add Device menu, select the desired device and press the Menu Select button.

The selected device must now go through the “Pairing” process described below.

**NOTE** All Bluetooth devices within the specified range are discovered by the HeartStart MRx and are displayed on the Add Device menu, even if you have already paired with the device.

### Pairing a Bluetooth Device with the HeartStart MRx

Once a Bluetooth device is selected from the Add Devices menu, a passkey sequence must be performed in order to communicate or “pair” the wireless device with the HeartStart MRx. The passkey is user-defined character sequence, such as 000, or 1234, etc.

Some Bluetooth devices only allow pairing for 30 seconds, so be ready to enter the passkey.

- 1 Use the Navigation buttons to enter the passkey on the MRx and select **Done**.  
The Bluetooth device prompts you for a passkey.
- 2 Enter the same passkey on your Bluetooth device. See the documentation that came with your Bluetooth device for instructions.
- 3 Select the designated profile from the Phone/Modem Profiles menu.

**NOTE** The profile contains specific information about the Bluetooth device that enables it to communicate with the 12-Lead Transfer Station. Your administrator sets up the profiles and can tell you which one to choose.


Once the Bluetooth device is paired with the HeartStart MRx and the profile selected, the HeartStart MRx performs a transmission test. After successfully connecting to the device and network, the message **Transmission Test Passed** is displayed. Press the Menu Select button to acknowledge the message. Should the transmission test fail, the message **Transmission Test Failed** is displayed, along with additional information about where the failure occurred. See Table 66 in "Troubleshooting".

**NOTE** There may be exceptions to the pairing process, particularly for devices that do not have a user interface. Please refer to the documentation for your Bluetooth device. Additionally, pairing may sometimes be referred to by other names, such as "bonding".

**NOTE** Pairing information is not retained when importing a configuration file from the data card. The devices must be paired again using the process above.

## Changing Bluetooth Profiles

Once you have added and paired a Bluetooth device, you can change its profile using the following steps:

- 1 In 12-lead mode, press the Menu Select  button.
- 2 From the 12-Lead Main Menu, select **Bluetooth Devices** and press the Menu Select button. A list of paired Bluetooth devices is displayed.
- 3 Using the Navigation buttons, select a device and press the Menu Select button.
- 4 To change a profile, select Change Profile and press the Menu Select button. A menu of configured profiles for that device is displayed, with the currently associated profile highlighted.
- 5 Select the profile you want to associate with the device.

The MRx tests the profile to determine if the Bluetooth device can communicate with the 12-Lead Transfer Station. Progress messages are displayed during the test. If the test is successful, the message **Transmission Test Passed** is displayed. Press the Menu Select button to acknowledge the message. Should the transmission test fail, the message **Transmission Test Failed** is displayed, along with additional information about where the failure occurred. See Table 66 in "Troubleshooting".

## Additional Bluetooth Device Information

Keep the following points in mind when working with Bluetooth devices:


- Many Bluetooth devices are not discoverable by default. Check your device's documentation to see if you need to enable discovery.
- As a general security practice, you should not leave your Bluetooth device in discoverable mode.
- Some devices require that you turn on the Bluetooth functionality.
- Some devices may prompt you to authenticate each time. Check your device's documentation to see if you can configure it to always communicate with the HeartStart MRx.
- Give your Bluetooth device an easily recognizable name as this is the name that appears on the MRx menus. The name should be no more than 15 characters in order for it to display properly on the HeartStart MRx.
- Bluetooth modems and fax machines use analog lines to transmit data. If you are transmitting using a Bluetooth modem, plug it into the analog line used by the fax machine.



## Transmitting to a Configured Site using Bluetooth

Upon acquisition of the 12-Lead ECG, the 12-Lead Report View is displayed.

To transmit the displayed 12-Lead Report to a previously configured destination:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Send** from the 12-Lead Main Menu and press the Menu Select button.
- 3 Using the Navigation buttons, select the destination site from the configured list (see Figure 70) and press the Menu Select button to select.
- 4 Select the transmission device from the configured list and press the Menu Select button to select.

**NOTE** If the profile associated with the Bluetooth device is configured as a landline, use the numeric menu to edit the configured dial prefix if necessary. To confirm the prefix, select Done from the menu and press the Menu Select button.

## Setting Up for RS 232 Transmission

12-Lead ECG Transmission using RS 232 requires a serial cable connected to the RS 232 Serial Port located on the back panel of the HeartStart MRx. See Figure 68. The cell phone is connected to the serial cable as shown in Figure 69.

**NOTE** For further information concerning the setup and configuration of transmission devices and the HeartStart MRx, refer to the *12-Lead Transmission Implementation Guide*. For further information concerning the 12-Lead Transfer Station, refer to the *12-Lead Transfer Station Instructions for Use*.

**Figure 68 RS 232 Serial Port Connection**

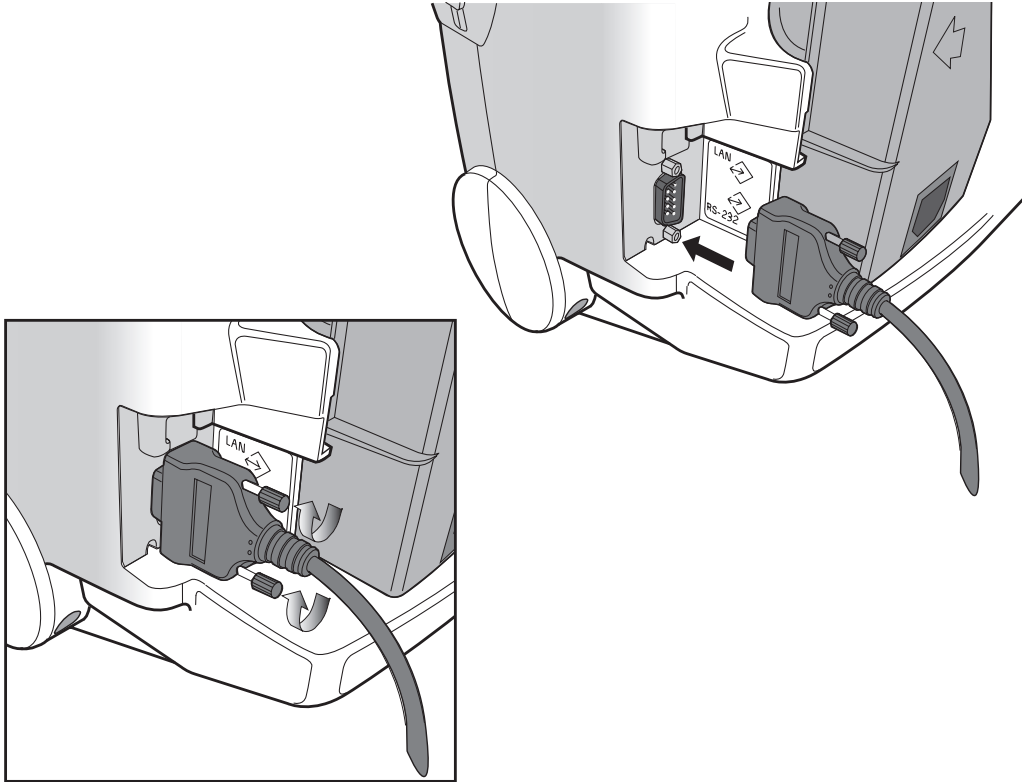
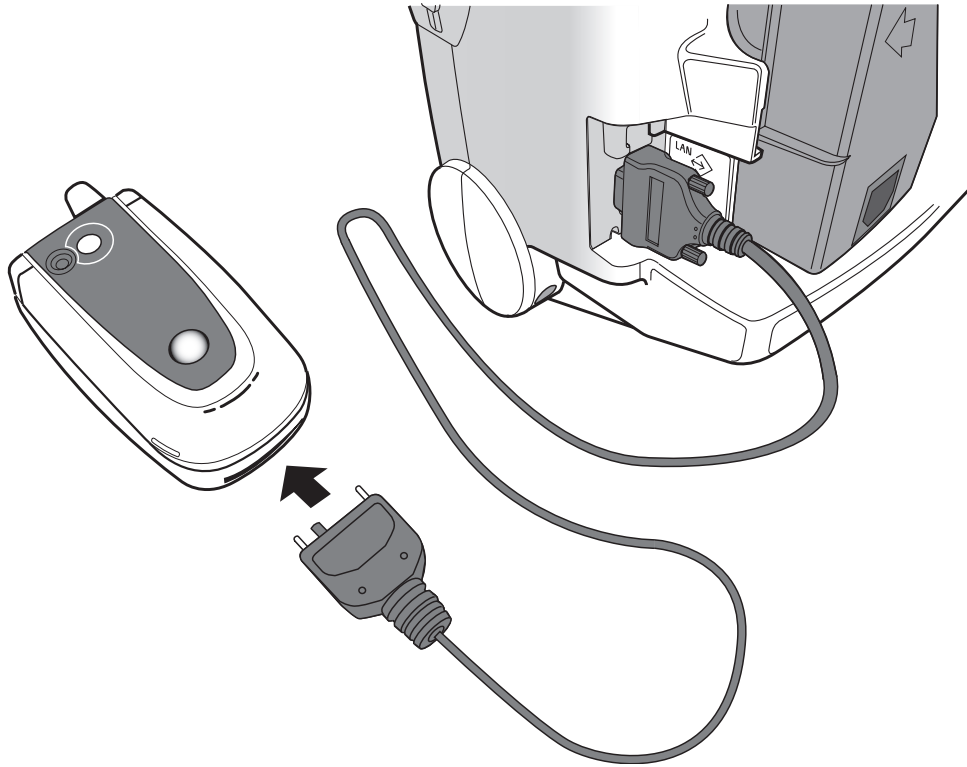



Figure 69 RS 232 Serial Cable Connection



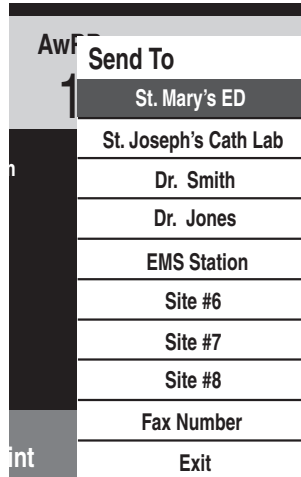
## Transmitting to a Configured Site Using RS 232

Upon acquisition of the 12-Lead ECG, the 12-Lead Report View is displayed.

To transmit the displayed 12-Lead Report to a previously configured destination:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Send** from the 12-Lead Main Menu and press the Menu Select button.
- 3 Using the Navigation buttons, select the destination site from the configured list (see Figure 70) and press the Menu Select button to select.

**Figure 70 12-Lead Send To Menu**




AwF	
Send To	
1	St. Mary's ED
	St. Joseph's Cath Lab
	Dr. Smith
	Dr. Jones
	EMS Station
	Site #6
	Site #7
	Site #8
	Fax Number
int	Exit

## Transmitting to a Manually Entered Fax Number

Upon acquisition of the 12-Lead ECG, the 12-Lead Report View is displayed.

To manually enter a fax number destination:

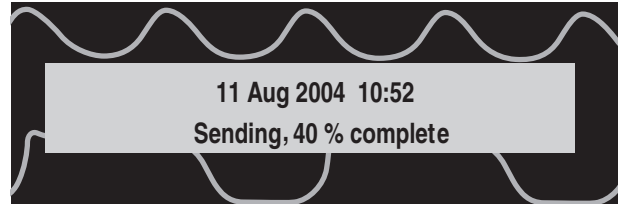
- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Send** from the 12-Lead Main Menu and press the Menu Select button.
- 3 Using the Navigation buttons, select **Fax Number** from the Send To Menu.
- 4 Enter the fax number from the numeric list using the Navigation buttons. Include any extra digits necessary, such as 9 for an outside line or 1 plus the area code for long distance.
- 5 Select **Done** and press the Menu Select button.

**NOTE** If you are transmitting to a manually entered fax number using a Bluetooth device, the device and landline prefix, if applicable, must be entered.

## Transmission Status

During 12-Lead Report transmittal, a status bar is displayed to show the progress of the connection and report transmission. Once the connection is made, the status bar contains the date and time stamp of the 12-Lead Report being sent. See Figure 71.

**Figure 71 12-Lead Transmission Status Bar**




The status bar continues to display in any clinical mode of operation.

**NOTE** 12-Lead Reports successfully transmitted to the hub are logged to the Event Summary and appear using the format, "12-Lead (12:25:33) Transmitted to *site name*".

## Transmitting Stored 12-Lead Reports

12-Lead Reports for the current patient that are stored in internal memory may also be transmitted. To transmit a stored 12-Lead Report:


- 1 From the 12-Lead Preview or Report View, press the Menu Select  button.
- 2 Using the Navigation buttons, select **Reports** from the 12-Lead Main Menu.
- 3 Using the Navigation buttons, scroll through the list of stored reports and highlight the desired report (Reports are identified by date/time stamp and sequence number). Press the Menu Select button to select.
- 4 Select **Send** from the 12-Lead Report Menu and press the Menu Select button.
- 5 Using the Navigation buttons, select the destination site or to manually enter a fax number. Press the Menu Select button to select.
- 6 For manual fax number entry, enter the fax number from the numeric list, select **Done** and press the Menu Select button.

Subsequent 12-Lead Reports can be placed in queue for transmittal while transmission is in progress, or the originally selected 12-Lead Report can be chosen for transmission to multiple sites.

**NOTE** If stored 12-Lead Reports are transmitted using a Bluetooth device, the Bluetooth device must be selected.

## Cancelling Transmission

To cancel a transmission once a connection has been initiated, perform the following steps:

- 1 From the 12-Lead Preview or Report View, press the Menu Select  button.
- 2 Select **Cancel Transmission** from the 12-Lead Main Menu and press the Menu Select button.
- 3 Confirm the cancellation by pressing the Menu Select button.

The transmission of any pending 12-Lead Reports is also canceled.

## Troubleshooting

If your HeartStart MRx does not operate as expected during 12-lead transmission, see "Troubleshooting" on page 249





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# Vital Signs Trending

This chapter describes how to review patient data using HeartStart MRx Vital Signs Trending.


## Overview

In Monitor Mode, your HeartStart MRx provides the ability to view and print numeric vital sign trending for the current incident. Trending data are automatically acquired if parameters are on.

When viewing trending, the Vital Sign Trending Report is displayed in the HeartStart MRx's lower two wave sectors and takes over the soft key functions. Trending data are presented at the selected interval for up to the most recent 12 hours of monitoring. The newest data appear when trending is initially displayed. The oldest measurements are deleted as needed to store the newest measurements.

## Reviewing Trending Data

To review trending data:

- 1 Place the HeartStart MRx into Monitor Mode.
- 2 Press the Menu Select  button.
- 3 Using the Navigation buttons, select **Trends** and press the Menu Select button.

The Vital Signs Trending Report takes over the bottom two wave sectors. See Figure 72.

Figure 72 Vital Signs Trending Report

**Date of report** - The earliest time displayed in the table determines the date of the report.

**Time intervals** - Vital Sign trends are displayed at the selected time interval. See “Vital Signs Trending Report Intervals” on page 159.

26 Apr	10:10	10:15	10:20	10:25	10:30	10:35	10:40	10:45	10:50
ABPd	72	72	72	72	72	72	72	72	72
ABPm	95	95	95	95	95	95	95	95	95
ICPm	9	9	9	9	9	8	8	9	9
CPPm	86	86	86	86	86	87	87	86	86
NBPs	120			117			120		120
NBPd	80			64			60		70
NBPm	95			81			88		82
EtCO2	10:06			10:23			10:38^		10:47
	38	38	37	38	39	35	36	38	39

**Timestamp indicator** - ^ indicates multiple measurements were taken during interval.

**Parameters** - A list of vital signs monitored by the MRx during the displayed time period.

**Trending data** - In the body of the report, vital sign units of measure are not displayed in the table.

## About The Data Displayed

- When trending is initially displayed, the latest (most recent) trending data will appear in the far right column.
- The display will auto-update as new vital sign data become available as long as the latest data are displayed on screen. If you have scrolled left to view older data, the screen will not update to new data when available. The latest data will be displayed when scrolling back to the most recent data.
- If a parameter has not been measured during the display period, it is not listed in the display.
- If a parameter in the display has invalid information, it is indicated by **-?-**. Questionable data are indicated by a question mark just before the numeric value and unavailable data are indicated by an empty space.
- Aperiodic measurements (e.g. NBP) are displayed with a measurement timestamp below the readings. A ^ after the timestamp indicates multiple measurements were taken during the interval. The most recent measurement within the interval is displayed.
- If an inactive parameter becomes active when viewing a Vital Signs Trending Report, the added parameter will automatically appear in the report when the interval is updated and the latest data is available.

**NOTE** When the time interval in the Vital Signs Trending Report is one minute, data from continuous measurements represents the average reading for that one-minute period. For all other time intervals, the measurement shown is the one-minute average from the most recent minute in the time interval.

## Vital Signs Trending Report Parameter List Order

Vital Signs Trending Reports list parameters in the following order, beginning at the top of the table: HR, P1, P2, ABP, Ao, ART, PAP, RAP, CVP, LAP, ICP, CPP, NBP, EtCO<sub>2</sub>, AwRR, SpO<sub>2</sub>, Pulse, Temp.

If a parameter has not been measured during the display period, it is not listed in the display.

## Scrolling in the Vital Signs Trending Report

Use the [ << ] or [ >> ] softkeys to scroll left and right (backward and forward) in the Vital Signs Trending Report. The softkey will be displayed as inactive if there is no more data to be viewed in a particular direction.


If there are more vital signs than can be shown on the screen, use the Navigation buttons next to the Menu Select button to scroll up and down with the vertical scroll bar on the display. Make sure there is not a menu active at the same time.

## Vital Signs Trending Report Intervals

Vital Signs Trending data can be shown at selected intervals for up to 12 hours of monitoring. You can adjust the display's time interval for the current incident to 1, 5, 10, 15, 30 or 60 minutes. The default is 5 minutes.

## Adjusting Vital Signs Trending Report Interval

To adjust the intervals in the Vital Signs Trending report, perform the following steps:

- 1 With Vital Signs Trending active on your display, press the Menu Select  button.
- 2 Using the Navigation buttons, select **Trend Interval** and press the Menu Select button.
- 3 Using the Navigation buttons, select the trend interval you want and press the Menu Select button.

## Printing the Vital Signs Trending Report

You can print the Vital Signs Trending Report two ways:

- 1 Press the soft key under the **Print Trends** label. A report for the displayed period and interval is printed.
- 2 Press the Summary **i** button and select **Trends** and then **Trends Interval**. A report for the entire incident period is printed.

**Figure 73 Sample Vital Signs Trending Report Printout**

Trend Report	26 Apr	10:55	10:50	10:45	10:40	10:35	10:30	10:25
DD Mon YYYY HH:MM	HR bpm	100	100	100	100	100	100	100
	P2s mmHg	25	25	25	25	25	25	25
Event ID: 0302	P2s mmHg	10	10	10	10	10	10	10
LastName,First Name	P2s mmHg	16	16	16	16	16	16	16
Patient ID:12345	ABPs mmHg	118	118	118	118	118	118	118
	ABPd mmHg	72	72	72	72	72	72	72
	ABPm mmHg	95	95	95	95	95	95	95
M3535A S/N:US00112345								
SW Rev: 7.00.00 American English								

1st "page"

26 Apr	10:55	10:50	10:45	10:40	10:35	10:30	10:25
NBPs mmHg	120			120			117
NBPd mmHg	70			60			64
NBPm mmHg	82			80			81
	10:47			10:30			10:23
EtCO2 mmHg	39	39	38	36	35	39	39
AwRR rpm	12	12	12	12	12	12	12
SpO2 %	100	100	100	100	100	100	100
Pulse bpm	95	95	95	95	95	95	95
Temp F	99.0	99.0	99.0	99.0	99.0	99.0	99.0

2nd "page"

See "Printing the Vital Signs Trending Report" on page 206 for more information.

**NOTE** If your device has a 50mm printer its report will have 11 lines of text. If the device has a 75mm printer, the report contains 16 lines.

## Exiting Vital Signs Trending Report

To exit the Vital Signs Trending Report and return to a waveform display, press the soft key under the **[Close Trends]** label in the Vital Signs Trending Report display. You will be returned to Monitor Mode.

## Troubleshooting

If your HeartStart MRx does not operate as expected during Vital Signs Trending, see Chapter 20, “Troubleshooting.”



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# Q-CPR and Data Capture

## Overview

The Q-CPR™ option offers real-time measurement and corrective feedback on the rate, depth, and duration of compressions, as well as the frequency and volume of ventilations. It also provides notification of lack of CPR activity.

Compressions are measured by the Compression Sensor connected to the HeartStart MRx using the M4763A Pads/CPR cable. Ventilation data is acquired through Philips multifunction defib electrode pads applied to the patient and connected to the HeartStart MRx using the same Pads/CPR cable.

Q-CPR is available in both Manual Defib Mode and AED Mode. In both modes, easy-to-follow audio prompts and visual indicators are provided as feedback to the rescuer when CPR performance deviates outside of target ranges. (See the *Q-CPR Application Note* for more information on Q-CPR.)

The Q-CPR Data Capture option enables you to capture data on CPR quality from the HeartStart MRx using the Q-CPR option. The Q-CPR Data Capture option enables the storage of CPR-related data for retrospective review and analysis using Q-CPR Review software available from Laerdal Medical Corporation. (See the *Q-CPR Review Directions for Use* for more information on Q-CPR Review software.)

**NOTE** Events related to Q-CPR are not stored in the HeartStart MRx Event Summary.

---

**WARNING** Q-CPR is available for use with the HeartStart MRx only.

The Q-CPR option is not intended for use in a moving environment, such as an ambulance. Additional movement introduced during patient transport may reduce the accuracy of the compression and ventilation measurements. If Q-CPR must be used in a moving environment, do not rely on the Q-CPR feedback during such conditions. It is not necessary to remove the Compression Sensor from the patient.

Q-CPR is not to be used on patients under 8 years of age or less than 25 kg.

The Q-CPR option should not be used to verify placement of airway adjuncts, such as endotracheal tubes and laryngeal masks.

Ventilation feedback accuracy may be decreased when the patient is handled or moved, or when the Q-CPR option is used on patients with certain conditions such as trauma, seizures, reduced lung volume, or high cardiac ejections.

CPR is best performed when the patient is lying on a firm surface. If the patient is on a compliant surface such as a mattress, the patient should be placed on a backboard.

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**CAUTION** The Q-CPR option is not intended for use with any other CPR compression devices.

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# Preparing to Use Q-CPR

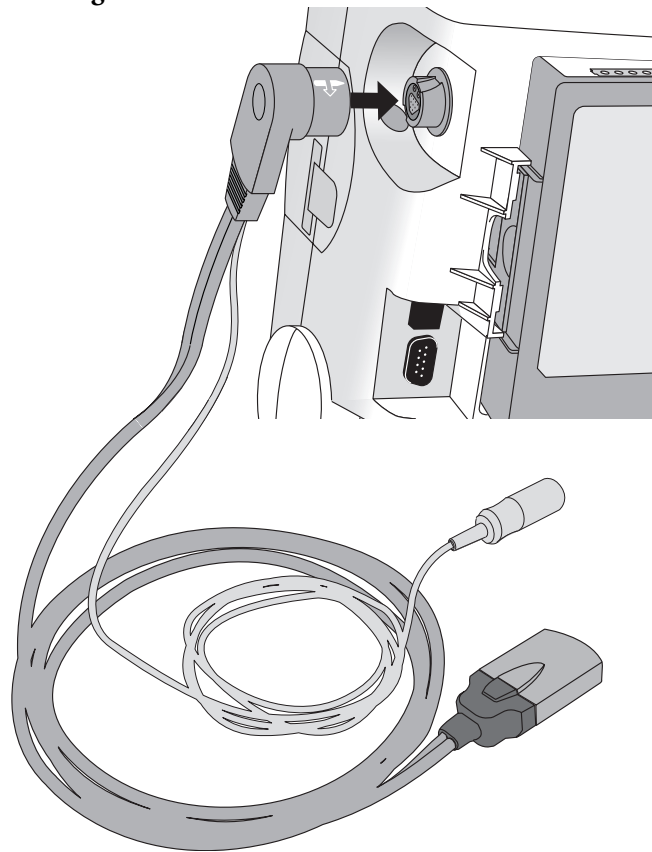
The Q-CPR option requires the use of the Pads/CPR cable. To set up the Q-CPR option on the HeartStart MRx and prepare the patient for use, follow the steps described below.

## Connecting the Pads/CPR Cable

To connect the Pads/CPR cable:

- 1 Align the white pointer on the cable with the white arrow on the green Therapy port as shown in Figure 74.
- 2 Insert the cable into the green Therapy port. Push until you hear it click into place. As a time saving measure, you may choose to always keep your Pads/CPR cable pre-connected to the MRx.

**Figure 74** Connecting the Pads/CPR Cable



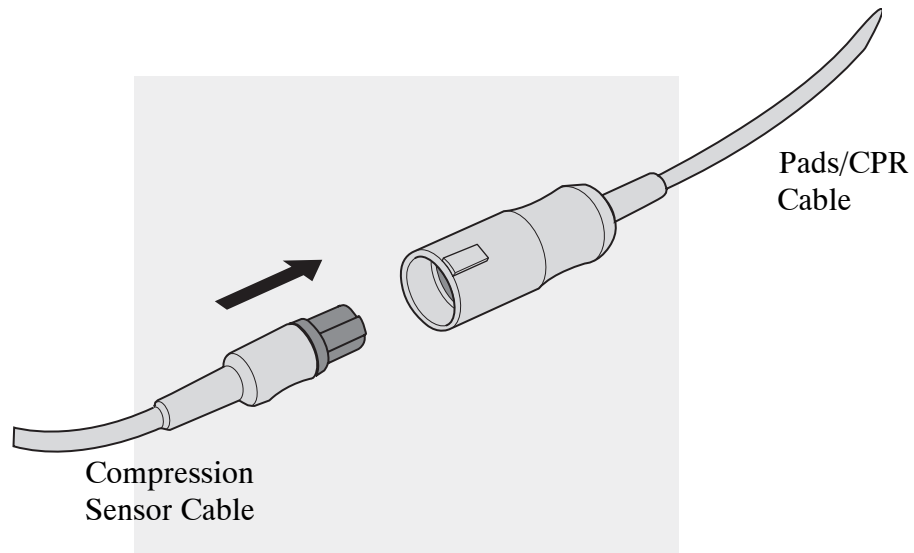
**NOTE** The Q-CPR option is operational only when the Pads/CPR cable is connected to the HeartStart MRx. CPR feedback is not available if the standard pads or paddles cable is connected.

## Connecting the Compression Sensor to the Pads/CPR Cable

To connect the Compression Sensor to the Pads/CPR cable:

- 1 Align the key marker on the Compression Sensor cable with the key marker on the receptacle end of the Pads/CPR cable as shown in Figure 75. As a time saving measure, you may choose to always keep your Compression Sensor cable pre-connected to the Pads/CPR cable.
- 2 Push until you hear it click into place.

**Figure 75 Attaching the Compression Sensor to the Pads/CPR Cable**

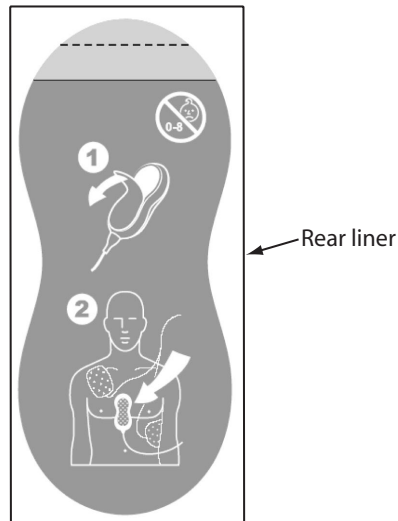


## Attaching the Compression Sensor Adhesive Pad

To attach the Compression Sensor Adhesive Pad to the Compression Sensor:

- 1 Peel the rear liner from the bottom of the Compression Sensor Adhesive Pad. (The rear liner is blank and does not contain any graphics.) Figure 76 illustrates the pad.

**Figure 76 Compression Sensor Pad**



- 2 Align the bottom of the Compression Sensor Adhesive Pad with the yellow area of the Compression Sensor and press into place. The diagram on the Compression Sensor bottom depicts Compression Sensor Adhesive Pad application as shown in Figure 77.

**Figure 77 Compression Sensor Bottom**



**NOTE** The Compression Sensor Adhesive Pad is intended for single-patient use only. It should be replaced after each use.

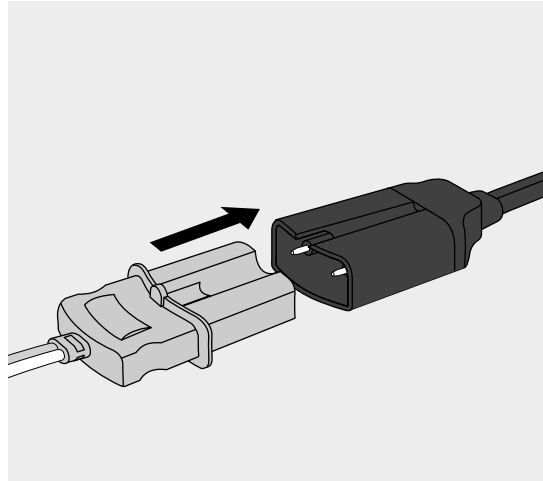
**NOTE** The Compression Sensor should always be stored with the Compression Sensor Adhesive Pad in place as described above.

## Applying Multifunction Electrode Pads

To apply pads to the patient:

- 1 Check the expiration date that appears on the pads package.
- 2 Inspect the packaging for any damage.
- 3 Connect the pads connector to the Pads/CPR cable. See Figure 78.

**Figure 78 Pads Connection**



- 4 Apply the pads to the patient in the anterior/anterior position as shown on the pads package.

---

**CAUTION** Philips multifunction defib electrode pads are required to measure ventilation activity, as well as acquire an ECG signal and deliver a shock, as appropriate.

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**WARNING** Anterior-posterior pad placement should not be used with the Q-CPR option.

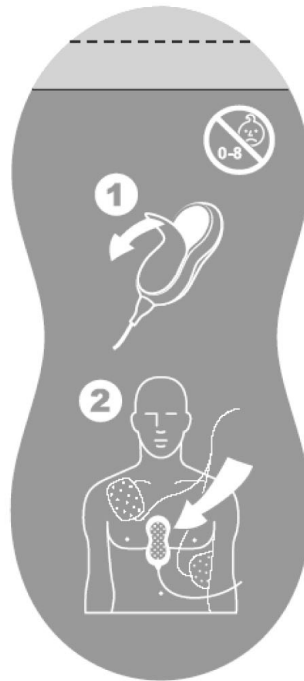
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## Placing the Compression Sensor on the Patient

To place the Compression Sensor on the patient:

- 1 Ensure the patient's skin is clean and dry. If necessary, clip or shave the hair from the sternum area.
- 2 Using the yellow pull tab on the top liner, peel the green liner away from the Compression Sensor Adhesive Pad. See graphic 1 in Figure 79.
- 3 Position the Compression Sensor on the patient as shown in graphic 2 displayed on the green liner, applying the Compression Sensor Adhesive Pad on the patient. The proper location is on the lower half of the sternum. See graphic 2 in Figure 79.

**Figure 79** Compression Sensor Adhesive Pad



When the Compression Sensor is on the patient's chest, the flat gray surface should be facing up. When using Q-CPR, place the heel of your hand on the flat gray surface in the same way that you would position your hand on the patient's chest if performing CPR without the Compression Sensor.

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**WARNING** Do not apply the Compression Sensor to an open wound or recent incision site.

---

## Using Q-CPR in Manual Defib Mode

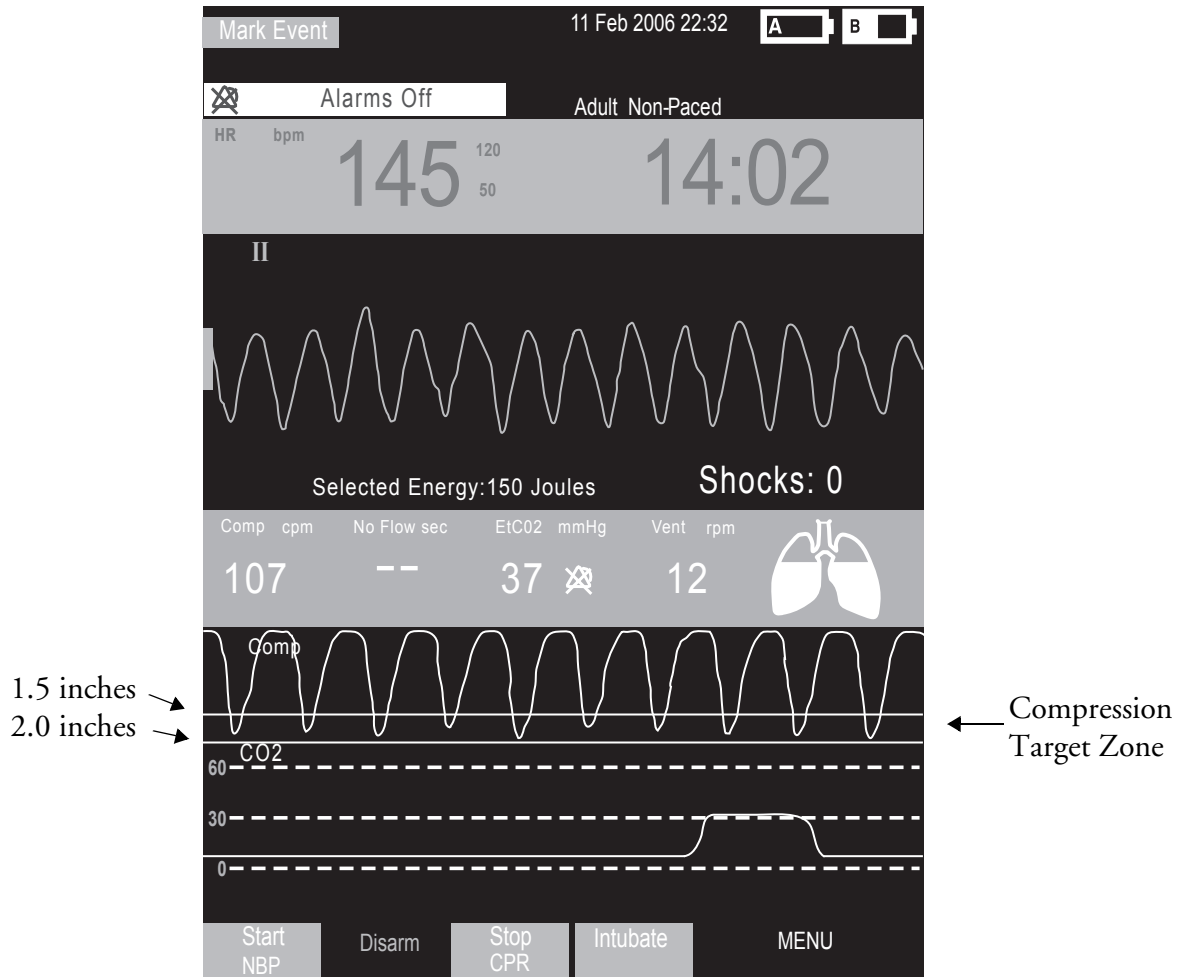
When the Therapy Knob is moved to the 150J Manual Defib setting, the CPR sub view is automatically displayed only if the Sync function is disabled, patient category is Adult, and patient age is equal to or greater than 8 years old. The CPR sub view is automatically displayed after the Manual Therapy Security password is entered, only if Manual Defib Mode is password protected.

When the Therapy Knob is located on any other Manual Defib setting, a compression of the Compression Sensor displays the CPR sub view. The CPR sub view may also be manually displayed by pressing the [**Start CPR**] soft key. Also, the patient category must be Adult and the patient age must be equal to or greater than 8 years old to display the sub view for either action.

Wave forms for ECG, invasive pressure (ABP, ART Ao or PAP) and CO<sub>2</sub> parameters can be viewed during the use of Q-CPR. If an ABP, ART Ao or PAP pressure measurement is active, the waveform always appears in Wave Sector 3 and the pressure value displays in Parameter Block 2. If two pressures labeled ABP, ART, Ao or PAP are available, the label assigned to Pressure 1 is displayed. If no pressure is active, then the compression waveform appears in Wave Sector 3. Parameter Block 2 displays compression and ventilation measurement information. The EtCO<sub>2</sub> waveform will appear in Wave Sector 4 if present. AwRR numeric values are not displayed.

- NOTE** If the Pads/CPR cable is not connected when you turn the Therapy Knob to Manual Defib Mode, the message **Connect Pads/CPR Cable** displays.
- NOTE** When using Q-CPR, SpO<sub>2</sub> monitoring functionality is not available.
- NOTE** Compression and ventilation measurement values are printed in the annotation area of the ECG printed strip.

Figure 80 Display View in Manual Mode with Q-CPR



## Compression Waveform

If you do not have an invasive pressure waveform (ABP, ART, Ao or PAP) displayed, the compression waveform appears in Wave Sector 3 and is labeled **Comp**. The waveform is drawn at a speed of 12.5 mm/second. As the chest is compressed, the compression is shown as a downward stroke of the wave, rebounding up to a baseline as compression pressure is released. The wave sector contains lines drawn at minus 38 mm and minus 51 mm (minus 1.5 inches and minus 2 inches) that define a target zone to help you achieve good compression depth. Good compression depth is achieved when the peak, or minimum value, of the waveform appears between the lines. When pressure is not released between compressions, an asterisk (\*) will annotate the baseline segment between compressions. This is also referred to as “leaning”. If the signal from the Compression Sensor becomes invalid (e.g., the sensor is disconnected), the waveform appears as a dashed line.

## Parameter Block 2

In the CPR sub view, Parameter Block 2 contains the numeric values for compression rate, as well as ventilation rate. Both rates are a moving average rate, measured per minute. Based on the Q-CPR algorithm, the target compression rate is 100 compressions per minute within an acceptable range of 90-120 compressions per minute. The acceptable range for ventilation rate while CPR is being administered is 4-16 ventilations per minute (to reflect 2005 resuscitation guidelines).

The acceptable range for ventilation rate following 60 seconds without compressions (such as while rescue breathing is being administered) is 9-16 ventilations per minute.

If your device does not have invasive pressure active, the ventilation volume icon is displayed in Parameter Block 2 and depicts the level of ventilation volume. A set of lungs graphically shows the four states of volume, gradually moving from empty, to one-third full, then two-thirds full, and full. See Figure 81. After a brief display, the icon returns to the empty state. If ventilation cannot be measured, lungs marked with a “- ? -” appear.

**Figure 81 Ventilation Volume Icons**




**NOTE** The filling of the ventilation volume icon indicates that a ventilation was detected, and the ventilation's magnitude is indicated by the filling of the icon.

---

**WARNING** The graphical display of a set of lungs does not signify the actual filling (ventilation) or presence of both lungs in the patient. The actual ventilation volume associated with filling of the lung icon will vary from patient to patient. Actual tidal volumes should be determined based on chest rise.

---

Parameter Block 2 also contains a numeric value for No Flow Time. If no compressions are detected, the No Flow Timer starts. The No Flow Time value is displayed, beginning at 2 seconds and incremented with each additional second. A voice prompt is given every 15 seconds that compression activity is not detected. The No Flow Time value is reset when a compression occurs or when the Shock  button on the HeartStart MRx is pressed. If the No Flow Time value exceeds 1 minute, it is assumed that CPR compression activity has stopped intentionally and the value is reset to two dashes (- -).

If monitoring CO<sub>2</sub>, the EtCO<sub>2</sub> numeric value is displayed in Parameter Block 2, along with its alarm limits.



## Soft Keys

From Code View in Manual Defib Mode, press the [**Start CPR**] soft key to display the CPR sub view shown in Figure 80. This soft key is then labeled [**Stop CPR**] and may be used to switch between the CPR sub view and the standard Code View of Manual Defib Mode.

**NOTE** Pressing the [**Start CPR**] soft key turns off the Sync function. Conversely, pressing the Sync button turns off the CPR sub view.

**NOTE** The [**Start CPR**] soft key is disabled if patient category is Pedi or patient age is less than 8 years old.

The [**Intubate**] soft key is also displayed in the CPR sub view. When you press this soft key, its label changes to [**Intubated**]. When intubation is indicated in this way, the **Ventilate Less Forcefully** and **Ventilate a Little Less Forcefully** audio feedback is suppressed.

## Using Q-CPR in AED Mode

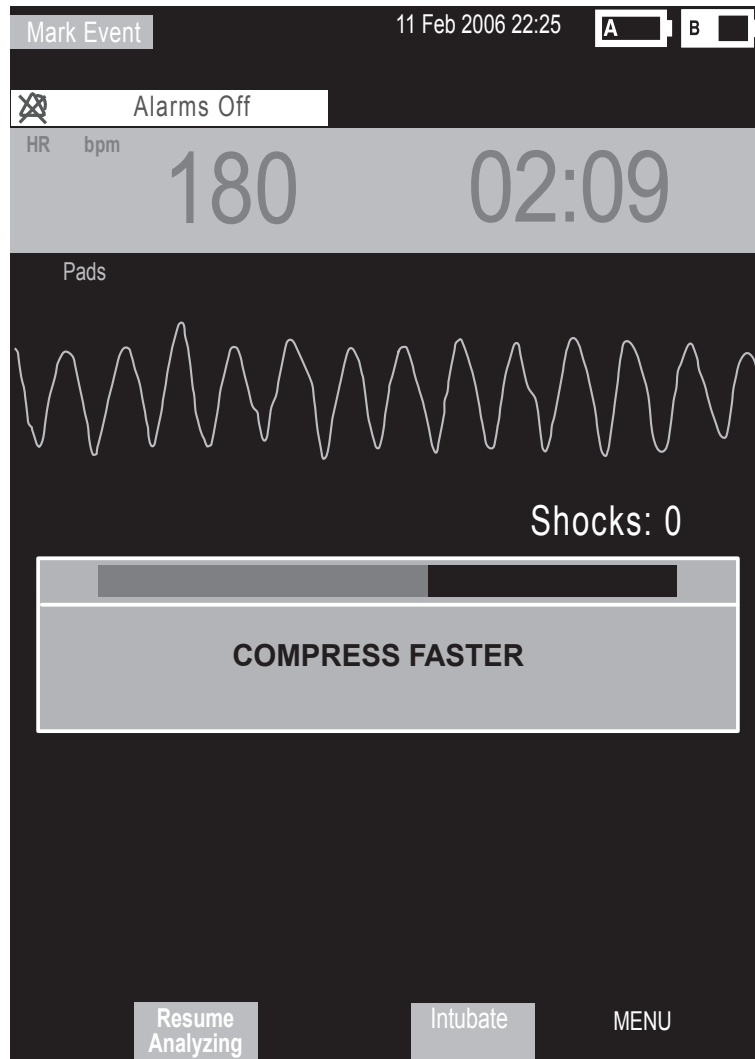
In AED Mode, Q-CPR provides CPR feedback automatically during the CPR Pause period of the AED protocol or manually when the [**Pause for CPR**] soft key is pressed. If your No Shock Advised (NSA) Action configuration item is set to provide a CPR Pause interval, Q-CPR can be activated by delivering a compression with the Compression Sensor.

The [**Intubate**] soft key is also displayed in AED Mode. When you press this soft key, its label changes to [**Intubated**]. The **Ventilate Less Forcefully** and **Ventilate a Little Less Forcefully** audio feedback is suppressed when intubation is active.

As in Manual Defib Mode, voice prompts are issued to guide you if necessary, however, in AED Mode they are accompanied by a momentary text message appearing on the display. A configurable CPR Timer status bar is also displayed. The time period of the CPR Timer is determined by the Configuration setting for CPR Pause Time. See Figure 82.

- NOTE** The CPR sub view in AED Mode displays the ECG waveform only. The compression waveform is not displayed while performing CPR in AED Mode.
- NOTE** If the Pads/CPR cable is not connected when you turn the Therapy Knob to AED Mode, the message **Connect Pads Cable** is displayed.
- NOTE** Compression and ventilation measurement values are printed in the annotation area of the ECG printed strip.

Figure 82 Display View in AED Mode with Q-CPR




← CPR Timer Status Bar

# CPR Feedback

## Adjusting CPR Feedback Volume

To adjust the volume of CPR feedback voice prompts:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Volume** from the menu and press the Menu Select button.
- 3 Select **Voice** and press the Menu Select button.
- 4 Select the desired volume level and press the Menu Select button.

A sample voice prompt is announced to confirm your selection.

**NOTE** In AED Mode, steps 2 and 3 are not applicable unless Q-CPR is active.

If desired, CPR feedback voice prompts may also be muted. When muted, a **CPR Voice Muted** text message displays in the middle of the wave sector containing the compression waveform during Manual Defib Mode or below the text prompt in AED Mode. CPR inactivity time is indicated by an audible tone.

To mute the CPR feedback voice prompts:

- 1 Press the Menu Select  button.
- 2 Press the Menu Select button again to select **Mute CPR Voice**.

To resume voice prompts set at the previously selected volume:

- 1 Press the Menu Select  button.
- 2 Press the Menu Select button again to select **Resume CPR Voice**.

**NOTE** Mute is only available when Q-CPR is active.

## Feedback Prompts

Table 22 lists the feedback prompts that may be issued during the use of Q-CPR.

**Table 22 CPR Feedback Prompts**

CPR Component	Problem	Voice Prompt	Accompanying Text Prompt (AED Mode only)
Compression Depth	Too shallow	Compress deeper	Compress deeper
	A little too shallow	Compress a little deeper	Compress a little deeper
	Too deep	Don't compress so deep	Don't compress so deep
	A little too deep	Don't compress quite so deep	Don't compress quite so deep
Compression Rate	Too slow	Compress faster	Compress faster
	A little too slow	Compress a little faster	Compress a little faster
	Too fast	Compress slower	Compress slower
	A little too fast	Compress a little slower	Compress a little slower
Compression Duration Time	Too short	Increase duration of each compression	Increase duration of each compression
Residual Pressure on the Patient's Chest	Incomplete release of compression (Leaning)	Release pressure between compressions	Release pressure between compressions
Ventilation Rate	Too low	Ventilate more often	Ventilate more often
	Too high	Ventilate less often	Ventilate less often
Ventilation Volume	Not enough volume	Give more volume	Give more volume
Ventilation Inflation Time	Too slow	Ventilate more forcefully	Ventilate more forcefully
	Too fast	Ventilate less forcefully	Ventilate less forcefully
	A little too fast	Ventilate a little less forcefully	Ventilate a little less forcefully
Compression Activity	15 seconds without sign of compressions	Fifteen seconds without sign of compressions	15 seconds without sign of compressions
	30 seconds without sign of compressions	Thirty seconds without sign of compressions	30 seconds without sign of compressions
	45 seconds without sign of compressions	Forty-five seconds without sign of compressions	45 seconds without sign of compressions
	60 seconds without sign of compressions	Sixty seconds without sign of compressions	60 seconds without sign of compressions
Ventilation Activity	30 seconds without sign of ventilations	Thirty seconds without sign of ventilations	30 seconds without sign of ventilations
	Ventilation feedback not given because of poor pads to patient contact or impedance > 140 ohms.	Press pads firmly to patient's bare chest	Press pads firmly to patient's bare chest

Table 22 CPR Feedback Prompts (Continued)

CPR Component	Problem	Voice Prompt	Accompanying Text Prompt (AED Mode only)
CPR Activity (compressions or ventilations)	15 seconds without signs of CPR	Fifteen seconds without signs of CPR	15 seconds without signs of CPR
	30 seconds without signs of CPR	Thirty seconds without signs of CPR	30 seconds without signs of CPR
	45 seconds without signs of CPR	Forty-five seconds without signs of CPR	45 seconds without signs of CPR
	60 seconds without signs of CPR	Sixty seconds without signs of CPR	60 seconds without signs of CPR

## Q-CPR Data Capture

This section describes how to configure Q-CPR Data Capture settings, lists the data and events recorded, and provides information on reviewing Q-CPR data.

### Q-CPR Feedback Setting

You can enable or suppress Q-CPR feedback, while still capturing CPR data. When Q-CPR feedback is enabled, the MRx displays the CPR sub view, with accompanying voice and/or text prompts.

When Q-CPR feedback is suppressed, the HeartStart MRx behaves in the following way:

#### Manual Defib Mode

- The CPR sub view (chest compression waves, compression rate and ventilation rate numerics, and no-flow time) is *not* displayed.
- There is *no* voice prompt feedback or storage of feedback events and prompts.
- INOPs regarding ventilation are *not* displayed.

#### AED Mode

- There is *no* Q-CPR voice or text prompt feedback or storage.
- INOPs regarding ventilation are *not* displayed.

### Research Storage Setting

When you enable Research Storage, in addition to the data and events listed in Table 23 the following data is captured:

- Compression Sensor acceleration data
- Compression Sensor force data
- Patient Contact Impedance (PCI) from multifunction electrode pads

## Data and Events Recorded

In addition to the standard HeartStart MRx defibrillation and monitoring events and ECG waveform, the following data and events related to Q-CPR are captured. Q-CPR feedback prompts are captured if the Q-CPR Feedback configuration option is set to On. However, these Q-CPR related events are not included in the Event Summary report printed by the HeartStart MRx.

**Table 23 Q-CPR Captured Data**

Captured Data	Description
Compression Waveform	Waveform showing compression depth versus time.
Ventilation Waveform	Waveform showing change in chest impedance versus time.
Ventilation Inflation Time	Duration of each ventilation.
Ventilation Volume	Maximum change in chest impedance for each ventilation.
CO <sub>2</sub> Waveform	Waveform showing CO <sub>2</sub> output versus time.
EtCO <sub>2</sub>	End tidal CO <sub>2</sub> measurement for each change in value.

## Reviewing Q-CPR Data

To review Q-CPR data:

- Copy the event data from the HeartStart MRx internal memory to an external data card. See the “Data Management” chapter for information.
- Import the data into the Q-CPR Review application. See the *Q-CPR Review Directions for Use* for more information.

## Troubleshooting

If your HeartStart MRx does not operate as expected during Q-CPR, see Chapter 20, “Troubleshooting.”



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# Configuration


This chapter describes the configurable parameters of the HeartStart MRx and the procedures for modifying configuration.

## Overview

Configuration settings allow you to customize the HeartStart MRx to best meet your needs. Configuration is performed through the Configuration menu of the device and may be saved to a data card for replication on multiple devices. At any time, configuration settings may be viewed and exported to a data card, and the date and time may be changed. However, a password is required to change the configuration of the device.

## Accessing the Configuration Menu

To access the Configuration Main menu:

- 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 Using the Navigation buttons, select **Configuration** and press the Menu Select button.

To return to normal operating mode, press the [**Exit Config**] soft key.

The Configuration Main menu is displayed, listing sub-menus for each category of configurable parameters. You may use this menu to view or print your device's configuration, as well as to modify the date and time settings. To modify any other settings, you must enter the configuration password printed on the front of the *HeartStart MRx User Documentation* CD-ROM.


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**WARNING** The HeartStart MRx should never be connected to a patient while performing configuration activities.

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## Setting the Date and Time


To modify the date and time setting from the Configuration menu:

- 1 Press the Menu Select  button.
- 2 Using the Navigation buttons, select **Date and Time**. Then press the Menu Select button.
- 3 Using the Navigation buttons, adjust the value for the year. Then press the Menu Select button.
- 4 Select the appropriate month. Then press the Menu Select button.
- 5 Adjust the value for the day. Then press the Menu Select button.
- 6 Adjust the value for the hour. Then press the Menu Select button.  
If the device is configured to use a 12-hour clock format, **am** or **pm** is displayed next to the hour.  
For a 24-hour format only the hour is shown, with choices from 0 to 23.
- 7 Press the **[Exit Config]** soft key if finished with configuration.

Date and time should be changed to correspond with local clock changes for Daylight Savings Time and Summer Time.

## Modifying Settings

When modifying configuration settings, the device should be connected to external power and have a battery with at least 20% capacity installed. To modify configuration settings, from the Configuration Main menu:

- 1 Press the **[Change Config]** soft key.
- 2 When prompted, enter the configuration password.
- 3 Press the Menu Select  button. Use the Navigation buttons to select the sub-menu for the category of parameters to be changed. Then press the Menu Select button.
- 4 Use the **[Prev Item]** and **[Next Item]** soft keys to select a parameter.
- 5 Use the Navigation buttons to highlight the desired choices. Press the Menu Select button to select the highlighted choice.
- 6 Repeat steps 3, 4 and 5 to select another sub-menu and modify additional settings.
- 7 Once the desired setting changes have been made, from the Configuration Main screen, press the **[Save Changes]** soft key.  
You may press the **[Cancel Changes]** soft key to return to the previous settings.
- 8 Press the **[Exit Config]** soft key to return to normal operating mode.  
If you press **[Exit Config]** before saving the changes, you are prompted with the message **Configuration Not Saved - Exit Anyway?** Select **No** and press the Menu Select button. Then press the **[Save Changes]** soft key.

## Saving Configuration Settings to a Data Card

To save configuration settings to a data card:

- 1 Make sure a data card is in the HeartStart MRx.
- 2 Press the [**Export**] soft key.

The HeartStart MRx copies the configuration settings to the data card.

## Loading Configuration Settings from a Data Card

To load configuration settings from a data card:

- 1 Insert the data card with the saved configuration in the HeartStart MRx.
- 2 Press the Change Config soft key and enter the configuration password.
- 3 Press the Import soft key.
- 4 Make any device specific configuration changes, such as 12-Lead location code.
- 5 Press the [**Save Changes**] soft key.

## Restoring the Default Settings

To return to using the configuration settings initially entered during manufacture:

- 1 Press the [**Change Config**] soft key.
- 2 Enter the Configuration password.
- 3 Press the [**Factory Defaults**] soft key.
- 4 Press the [**Save Changes**] soft key.

## Printing Configuration Settings

To print the configuration settings, select **Print Configuration** from the Configuration Main menu and press the Menu Select button. The configuration report is printed on the printer.

**NOTE** Upon exiting Configuration and returning to a clinical mode (Monitor, Pacer, Manual Defib or AED), all settings will be reset to the device's configured values.

## Configurable Parameters

The following tables list configurable parameters for each of the sub-menus on the Configuration Main menu. A description of each parameter is provided, along with the possible choices for settings. Default settings are in **bold** type.

**Table 24 General Settings**

Parameter	Description	Setting Choices
Voice Volume	Voice prompt volume level.	Very Soft, Soft, <b>Medium</b> , Loud, Very Loud
Alarm Volume	Audible alarm volume level.	Very Soft, Soft, <b>Medium</b> , Loud, Very Loud
Minimum Alarm Volume	Minimum audible alarm level available during use.	Very Soft, <b>Soft</b> , Medium, Loud, Very Loud
QRS Volume	Volume of audible beep with each QRS complex detected.	Off, Very Soft, Soft, <b>Medium</b> , Loud, Very Loud
Time Format	Selects time format to display.	12-hour, <b>24-hour</b>
Pacing on Batteries Warning	Displays the warning message <b>Pacing on Batteries</b> if pacing using only battery power.	Yes, No
Unit Display	Defines if parameter values are displayed with or without corresponding measurement units.	<b>On</b> , Off
Patient Category	Selects the default patient category.	<b>Adult</b> , Pedi
Device Owner	Identification for Return to Owner feature.	20 characters
Return to Owner Password	Password required in order to deactivate the loan period setting.	4 characters
Audio Recording	Turns audio recording on or off for Manual Defib or AED modes.	<b>On</b> , Off

**NOTE** The Return to Owner Password should be documented in a secure manner. Should it need to be reset, all configuration settings must be reset to factory default values, and the device must then be re-configured.

**NOTE** Do not set alarm volumes so low that you can't hear them in loud environments.

Table 25 Heart Rate and ECG Settings

Parameter	Description	Setting Choices
Auto Gain	Determines whether ECG size is automatically adjusted to the standard maximum wave size without clipping the wave sector. If auto-gain is off, the gain is set to 1 (10mm/mV).	On, Off
AC Line Filter	Selects the setting used to filter out AC line noise. Adjust this setting to the power frequency of your country.	60 Hz, 50 Hz
ECG Bandwidth for Display	Selects the display filter frequency for the attached therapy cable or 3-/5-lead ECG cable. (This setting does not affect 12-Lead View.)	.15-40 Hz Monitor, 1-30 Hz EMS
ECG Bandwidth for Printer	Selects the printer filter frequency for the attached therapy cable or 3-/5-lead ECG cable. (This setting does not affect 12-Lead Reports.) If Diagnostic is selected, pads ECG is set to Monitor.	0.05-150 Hz Diagnostic, .15-40 Hz Monitor, 1-30 Hz EMS
ECG Electrode Labels	Selects electrode label format. AAMI: RA, LA, LL, RL, V. IEC: R, L, F, N, C.	AAMI, IEC
HR/Pulse High Limit	Selects the default High Alarm Limit for the HR derived from the ECG and the pulse derived from SpO <sub>2</sub> or Invasive Pressures.	Adult: 35-200, <b>120</b> , (bpm) Pediatric: 35-240, <b>160</b> adjusted in increments of 5
HR/Pulse Low Limit	Selects default Low Alarm Limit for the HR derived from the ECG and the pulse derived from SpO <sub>2</sub> or Invasive Pressures.	Adult: 30-High Alarm Limit, <b>50</b> (bpm) Pediatric: 30- High Alarm Limit, <b>80</b> adjusted in increments of 5
VTACH	Detection of ventricular tachycardia based on heart rate limit and PVC run limit.	Heart Rate Limit: Adult: 95-150, <b>100</b> (bpm) Pediatric: 95-150, <b>120</b> adjusted in increments of 5  PVC run limit: Adult: 3-20, <b>5</b> Pediatric: 3-20, <b>5</b> adjusted in increments of 1
Color	Selects the HR/ECG color.	Red, Yellow, Blue, <b>Green</b> , Cyan, Magenta, White (Note: Red and blue text and numerics are not visible in high contrast mode.)

Table 26 Invasive Pressure Settings - Default Labels

Parameter	Description	Values / Default
Unit and Default Labels	Selects measurement units for all invasive pressures	mmHg, kPa
Press 1 Label	Selects default label for pressure channel 1	P1, ABP, ART, Ao, CVP, ICP, LAP, PAP, RAP
Press 2 Label	Selects default label for pressure channel 2	P2, ABP, ART, Ao, CVP, ICP, LAP, PAP, RAP,

Table 27 Invasive Pressure Settings - P1

Parameter	Description	Value/Defaults
Alarm Source	Selects the type of alarm source.	Systolic, Diastolic, Mean
Systolic High Limit	Selects the systolic high limit value.	Adult: -35 - 360, <b>160</b> (mmHg) Ped: -35 - 360, <b>120</b> Adjusted in increments of 5 mmHg or 1 kPa
Systolic Low Limit	Selects the systolic low limit value.	Adult: -40 - 355, <b>90</b> (mmHg) Ped: -40 - 355, <b>70</b> Adjusted in increments of 5 mmHg or 1 kPa
Diastolic High Limit	Selects the diastolic high limit value.	Adult: -35 - 360, <b>90</b> (mmHg) Ped: -35 - 360, <b>70</b> Adjusted in increments of 5 mmHg or 1 kPa
Diastolic Low Limit	Selects the diastolic low limit value.	Adult: -40 - 355, <b>50</b> (mmHg) Ped: -40 - 355, <b>40</b> Adjusted in increments of 5 mmHg or 1 kPa
Mean High Limit	Selects the mean high limit value.	Adult: -35 - 360, <b>110</b> (mmHg) Ped: -35 - 360, <b>90</b> Adjusted in increments of 5 mmHg or 1 kPa
Mean Low Limit	Selects the mean low limit value.	Adult: -40 - 355, <b>70</b> (mmHg) Ped: -40 - 355, <b>50</b> Adjusted in increments of 5 mmHg or 1 kPa
Scale	Selects the default wave form scale.	Adult: 300, 240, 180, <b>150</b> , 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, -5, -10, -15, -20 Pedi: 300, 240, 180, 150, 120, 110, <b>100</b> , 90, 80, 70, 60, 50, 40, 30, 20, 10, -5, -10, -15, -20
Artifact Suppression	Specifies the duration for suppressing pressure alarms due to non-physiological artifacts. An INOP is displayed.	30 sec., <b>60 sec.</b> , 90 sec., Off
Filter	Selects the filter setting.	<b>12 Hz</b> , 40 Hz
Color	Selects the P1 color.	Red, Yellow, Blue, Green, Cyan, Magenta, White. (Note: The High Contrast feature does not display the colors red or blue, therefore, be sure your device is configured correctly with appropriate parameter color settings.)

**Table 28 Invasive Pressure Settings - P2**

All setting options are exactly the same as P1 in Table 27 except for:

Parameter	Description	Value/Defaults
Color	Selects the P2 color.	Red, Yellow, Blue, Green, Cyan, Magenta, White

**Table 29 Invasive Pressure Settings - ABP, ART, Ao**

All setting options are exactly the same as P1 in Table 27

**Table 30 Invasive Pressure Settings - CVP, RAP, LAP**

Parameter	Description	Values / Default
Alarm Source		Source is always Mean and not configurable.
High Limit	Selects the high limit value.	Adult: -39 - 360, <b>10</b> (mmHg) Ped: -39 - 360, <b>4</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Low Limit	Selects the low limit value.	Adult: -40 - 359, <b>0</b> (mmHg) Ped: -40 - 359, <b>0</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Scale	Selects the default waveform scale	Adult: 300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, <b>20</b> , 10, -5, -10, -15, -20 Ped: 300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, <b>20</b> , 10, -5, -10, -15, -20
Artifact Suppression	Selects the default artifact suppression timeframe.	30 sec., <b>60 sec.</b> , 90 sec., Off
Filter	Selects the filter setting.	<b>12 Hz</b> , 40 Hz
Color	Selects the parameter color.	Red, Yellow, Blue, Green, <b>Cyan</b> , Magenta, White

Table 31 Invasive Pressure Settings - PAP

Parameter	Description	Values / Default
Alarm Source	Selects the type of alarm source.	Systolic, Diastolic, Mean
Systolic High Limit	Selects the systolic high limit value.	Adult: -39 - 360, <b>35</b> (mmHg) Ped: -39 - 360, <b>60</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Systolic Low Limit	Selects the systolic low limit value.	Adult: -40 - 359, <b>10</b> (mmHg) Ped: -40 - 359, <b>24</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Diastolic High Limit	Selects the diastolic high limit value.	Adult: -39 - 360, <b>16</b> (mmHg) Ped: -39 - 360, <b>4</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Diastolic Low Limit	Selects the diastolic low limit value.	Adult: -40 - 359, <b>0</b> (mmHg) Ped: -40 - 359, <b>-4</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Mean High Limit	Selects the mean high limit value.	Adult: -39 - 360, <b>20</b> (mmHg) Ped: -39 - 360, <b>26</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Mean Low Limit	Selects the mean low limit value.	Adult: -40 - 359, <b>0</b> (mmHg) Ped: -40 - 359, <b>12</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Scale	Default waveform scale	Adult: 300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, <b>20</b> , 10, -5, -10, -15, -20 Ped: 300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, <b>20</b> , 10, -5, -10, -15, -20
Artifact Suppression	Selects the default artifact suppression timeframe.	30 sec., <b>60 sec.</b> , 90 sec., Off
Filter	Selects the filter setting.	<b>12 Hz</b> , 40 Hz
Color	Selects the parameter color.	Red, <b>Yellow</b> , Blue, Green, Cyan, Magenta, White



Table 32 Invasive Pressure Settings - ICP

Parameter	Description	Values / Default
Alarm Source		Source is always Mean and not configurable.
High Limit	Selects the high limit value.	Adult: -39 - 360, <b>10</b> (mmHg) Ped: -39 - 360, <b>4</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Low Limit	Selects the low limit value.	Adult: -40 - 359, <b>0</b> (mmHg) Ped: -40 - 359, <b>0</b> Adjusted in increments of 1 mmHg or 0.1 kPa
Scale	Selects the default waveform scale	Adult: 300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, <b>20</b> , 10, -5, -10, -15, -20 Ped: 300, 240, 180, 150, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, <b>20</b> , 10, -5, -10, -15, -20
Artifact Suppression	Selects the default artifact suppression timeframe.	30 sec., <b>60 sec.</b> , 90 sec., Off
Filter	Selects the filter setting.	12 Hz, 40 Hz
Color	Selects the parameter color. (Also applies to CPP.)	Red, Yellow, Blue, Green, Cyan, <b>Magenta</b> , White

Table 33 Invasive Pressure Settings - CPP

Parameter	Description	Values / Default
Alarm Source		Source is always Mean and not configurable.
High Limit	Selects the high limit value.	Adult: -35 - 360, <b>130</b> (mmHg) Ped: -35 - 360, <b>100</b> Adjusted in increments of 5 mmHg or 1 kPa
Low Limit	Selects the low limit value.	Adult: -40 - 355, <b>50</b> (mmHg) Ped: -40 - 355, <b>40</b> Adjusted in increments of 5 mmHg or 1 kPa

Table 34 Noninvasive Blood Pressure Settings

Parameter	Description	Setting Choices
NBP Schedule	Selects the schedule for NBP measurements, manual, or automatic at the selected frequency.	<b>Manual</b> , q1, q2.5, q5, q10, q15, q30, q60, q120
NBP Alarm Source	Selects the alarm source.	<b>Systolic</b> , Diastolic, Mean
Unit	Selects the measurement units.	<b>mmHg</b> , kPa
Systolic High Limit	Selects the high limit alarm value used when systolic is the selected alarm source.	Adult: 35-270, <b>160</b> (mmHg) Pediatric: 35-180, <b>120</b> adjusted in increments of 5 mmHg or 1 kPa
Systolic Low Limit	Selects the low limit alarm value when systolic is the selected alarm source.	Adult: 30-265, <b>90</b> (mmHg) Pediatric: 30-175, <b>70</b> adjusted in increments of 5 mmHg or 1 kPa
Diastolic High Limit	Selects the high limit alarm value when diastolic is the selected alarm source.	Adult: 15-245, <b>90</b> (mmHg) Pediatric: 15-150, <b>70</b> adjusted in increments of 5 mmHg or 1 kPa
Diastolic Low Limit	Selects the low limit alarm value when diastolic is the selected alarm source.	Adult: 10-240, <b>50</b> (mmHg) Pediatric: 10-145, <b>40</b> adjusted in increments of 5 mmHg or 1 kPa
Mean High Limit	Selects the high limit alarm value when mean is the selected alarm source.	Adult: 25-255, <b>110</b> (mmHg) Pediatric: 25-160, <b>90</b> adjusted in increments of 5 mmHg or 1 kPa
Mean Low Limit	Selects the low limit alarm value when mean is the selected alarm source.	Adult: 20-250, <b>60</b> (mmHg) Pediatric: 20-155, <b>50</b> adjusted in increments of 5 mmHg or 1 kPa
Color	Selects the NBP color.	Red, Yellow, Blue, Green, Cyan, Magenta, <b>White</b>

Table 35 End-Tidal Carbon Dioxide Settings

Parameter	Description	Setting Choices
Unit	Selects the unit of measure	mmHg, kPa
EtCO <sub>2</sub> High Limit	Selects the high limit alarm value.	Adult: 20-95, <b>50</b> (mmHg) Pediatric: 20-95, <b>50</b> adjusted in increments of 1mmHg or 0.1 kPa
EtCO <sub>2</sub> Low Limit	Selects the low limit alarm value.	Adult: 10-94, <b>30</b> (mmHg) Pediatric: 10-94, <b>30</b> adjusted in increments of 1mmHg or 0.1 kPa
AwRR High Limit	Selects the high limit alarm value.	Adult: 10-100, <b>30</b> (rpm) Pediatric: 10-100, <b>60</b> adjusted in increments of 1
AwRR Low Limit	Selects the low limit alarm value.	Adult: 0-99, <b>8</b> (rpm) Pediatric: 0-99, <b>12</b> adjusted in increments of 1
Apnea Time	Length of time without respiration required to trigger an apnea alarm.	Adult: 10-40, <b>20</b> (seconds) Pediatric: 10-40, <b>20</b> adjusted in increments of 5
Color	Selects the EtCO <sub>2</sub> and AwRR color.	Red, <b>Yellow</b> , Blue, Green, Cyan, Magenta, White

Table 36 SpO<sub>2</sub> Settings

Parameter	Description	Setting Choices
SpO <sub>2</sub> High Limit	Selects high limit alarm value.	Adult: 51-100, <b>100</b> (%) Pediatric: 51-100, <b>100</b> adjusted in increments of 1
SpO <sub>2</sub> Low Limit	Selects low limit alarm value.	Adult: 50-99, <b>90</b> (%) Pediatric: 50-99, <b>90</b> adjusted in increments of 1
SpO <sub>2</sub> Desat Limit	Selects extreme low limit alarm value.	Adult: 50-low limit, <b>80</b> (%) Pediatric: 30-low limit, <b>80</b> adjusted in increments of 1
Color	Selects the SpO <sub>2</sub> color.	Red, Yellow, Blue, Green, Cyan, Magenta, White

Table 37 Pulse Settings

Parameter	Description	Values / Default
Pulse Source	Sets default pulse source	SpO <sub>2</sub> , Press 1: label, Press 2: label Default: SpO <sub>2</sub> if device has SpO <sub>2</sub> option, otherwise Press 1

Note: Pulse is only included in the Configuration menu if your device has the Invasive Pressures option.

Table 38 Temperature Settings

Parameter	Description	Values / Default
Unit	Selects measurement units	°C, °F
Label	Selects the default temperature label	Temp, Tskin, Trect, Tnaso, Tesoph, Tart, Tven, Tvesic, Tcore
High Limit	Selects the high limit value.	Adult: 0.1 to 45.0, <b>39.0</b> °C (32.2 to 113 °F) Ped: 0.1 to 45.0, <b>39.0</b> °C Adjusted in increments of 0.1 °C or 0.2 °F.
Low Limit	Selects the low limit value.	Adult: 0.0 to 44.9, <b>36.0</b> °C (32.0 to 112.8 °F) Ped: 0.0 to 44.9, <b>36.0</b> °C Adjusted in increments of 0.1 °C or 0.2 °F.
Color	Selects the temperature color.	Red, Yellow, Blue, <b>Green</b> , Cyan, Magenta, White

Table 39 Wave Sector Settings

Parameter	Description	Setting Choices
Wave 1	Selects the waveform displayed in Wave Sector 1.	Pads, I, II, III, aVR, aVL, aVF, V
Wave 2	Selects the waveform displayed in Wave Sector 2.	Pads, I, II, III, aVR, aVL, aVF, V, CO <sub>2</sub> , Pleth, Press 1, Press 2, Cascade, Annotated ECG, None <b>Default:</b> Press 1 if you have the Invasive Pressures option, Cascade otherwise.
Wave 3	Selects the waveform displayed in Wave Sector 3.	Pads, I, II, III, aVR, aVL, aVF, V, CO <sub>2</sub> , Pleth, Press 1, Press 2, None <b>Default:</b> Press 2 if you have the Invasive Pressures option, Pleth if you have SpO <sub>2</sub> , none otherwise.
Wave 4	Selects the waveform displayed in Wave Sector 4.	Pads, I, II, III, aVR, aVL, aVF, V, CO <sub>2</sub> , Pleth, Press 1, Press 2, Cascade, None <b>Default:</b> CO <sub>2</sub> if you have the CO <sub>2</sub> option, none otherwise.

Table 40 Alarm Settings

Parameter	Description	Setting Choices
Alarm Tone	Selects either traditional Philips or IEC Standard alarm tones.	<b>Philips</b> , IEC
Alarm Pause Time	Selects the interval of time during which alarms are paused, after the Alarm Pause button is pressed.	1, 2, 3, 5, 10, indefinite (minutes)

Table 41 12-Lead Settings

Parameter	Description	Setting Choices
Institution Name	Enters your organization's name for printing on the 12-Lead ECG Report.	32 characters, <b>blank</b>
Location Code	Enters an institution number and a department number for printing on the 12-Lead Report.	3 digits, <b>blank</b> (institution number) 2 digits, blank (department number)
Device ID	Enters a device identification number.	4 digits, <b>blank</b>
Analysis	Defines the analysis information included on the 12-Lead Report. None prints waveforms, Event/patient ID, date and time. Measurements Only adds HR, interval and axis measurements Standard adds severity, interpretive statements and reasons.	None, Measurements Only, <b>Standard</b>
ECG Bandwidth for 12-Lead Display	Defines the default ECG bandwidth for the 12-Lead preview display.	.15-40 Hz, <b>.05-40 Hz</b> , .05-150 Hz
ECG Bandwidth for 12-Lead Report	Defines the default ECG bandwidth for printed and stored 12-Lead Reports.	<b>Same as Display</b> , .05-150 Hz
Number of Automatic Printouts	Selects the number of 12-Lead ECG Reports printed at the completion of analysis.	0, 1, 2
Printer Format	Selects the number of rhythm strips to be printed with the 12-Lead Report, 0, 1, or 3.	3x4, <b>3x4 1R</b> , 3x4 3R
Rhythm Strip #1	Selects the first rhythm strip printed in the 3x4 1R or 3x4 3R format.	I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6
Rhythm Strip #2	Selects the second rhythm strip printed for reports in the 3x4 3R format.	I, II, III, aVR, aVL, <b>aVF</b> , V1, V2, V3, V4, V5, V6
Rhythm Strip #3	Selects the third rhythm strip printed for reports in the 3x4 3R format.	I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, <b>V5</b> , V6

**NOTE** If the same configuration file is used to configure multiple devices, be sure to assign a unique device ID number to each device.

**NOTE** The 3x4 3R Printer Format Setting is not for use with the 12-Lead Transmission option.

**Table 42 12-Lead Transmission Settings (Bluetooth and Modem Profile)**

Parameter	Description	Setting Choices
Profile Name	Name of the profile.	20 characters, <b>blank</b>
Configuration String	Available from your cell phone service provider.	45 characters, <b>blank</b>
Landline	Set to Yes if you are using a modem.	Yes, <b>No</b>
Dial Prefix	Only configurable if Landline is set to Yes. The dial prefix is the number or numbers you dial before the phone number. For example, you may need to dial a 9 for an outside line or an area code in addition to the number.	10 characters, <b>blank</b>
Dial String	Available from your cell phone service provider.	40 characters, <b>blank</b>
Wait for Dial Tone	Available from your cell phone service provider.	Yes, <b>No</b>
PPP User Name	Typically not needed but may be required by some cell phone service providers.	30 characters, <b>blank</b>
PPP Password	Typically not needed but may be required by some cell phone service providers.	40 characters, <b>blank</b>
Static IP Address	Typically not needed but may be required by some cell phone service providers.	15 characters (nnn.nnn.nnn.nnn), <b>blank</b>
Primary DNS	Typically not needed but may be required by some cell phone service providers.	nnn.nnn.nnn.nnn, <b>blank</b>
Secondary DNS	Typically not needed but may be required by some cell phone service providers.	nnn.nnn.nnn.nnn, <b>blank</b>
http Proxy Address	Typically not needed but may be required by some cell phone service providers.	15 characters, <b>blank</b>
http Proxy Port	Typically not needed but may be required by some cell phone service providers.	15 characters, <b>blank</b>

Table 43 12-Lead Transmission Settings (Serial Phone Profile)

Parameter	Description	Setting Choices
Profile Name	Name of the profile.	Serial Phone Profile
Configuration String	Available from your cell phone service provider.	45 characters, <b>blank</b>
Dial String	Available from your cell phone service provider.	40 characters, <b>blank</b>
Wait for Dial Tone	Available from your cell phone service provider.	Yes, <b>No</b>
PPP User Name	Typically not needed but may be required by some cell phone service providers.	30 characters, <b>blank</b>
PPP Password	Typically not needed but may be required by some cell phone service providers.	40 characters, <b>blank</b>
Static IP Address	Typically not needed but may be required by some cell phone service providers.	15 characters (nnn.nnn.nnn.nnn), <b>blank</b>
Primary DNS	Typically not needed but may be required by some cell phone service providers.	nnn.nnn.nnn.nnn, <b>blank</b>
Secondary DNS	Typically not needed but may be required by some cell phone service providers.	nnn.nnn.nnn.nnn, <b>blank</b>
http Proxy Address	Typically not needed but may be required by some cell phone service providers.	15 characters, <b>blank</b>
http Proxy Port	Typically not needed but may be required by some cell phone service providers.	15 characters, <b>blank</b>
Baud Rate	Available from your cell phone documentation. If your phone transmits “high speed” data, set to 115200.	9600, 19200, 38400, 57600, 115200
Flow Control	Available from your cell phone documentation.	None, <b>Hardware</b>



Table 44 12-Lead Transmission Settings (Hub)

Parameter	Description	Setting Choices
Server URL	Hub server address. Available from your ISP.	40 characters, <b>blank</b>
User Name	http user name. Use your web server documentation to create user accounts on the hub.	30 characters, <b>blank</b>
Password	http password. Use your web server documentation to create user accounts on the hub.	40 characters, <b>blank</b>

Table 45 12-Lead Transmission Settings (Site)

Parameter	Description	Setting Choices
Site Name	This label appears in the Send To menu when initiating a 12-Lead Report transmission. The label should be an easy to recognize name.	12-20 characters, <b>blank</b>
Site Type	Indicates the type of device receiving the 12-Lead Report.	<b>Fax</b> , <b>Printer</b> , <b>12LTS</b> , <b>TraceMaster</b> , <b>Hub</b>
Phone Number	Phone number for fax site type, otherwise N/A. <b>Note:</b> It is important that the you know the dialing rules from the 12-Lead Transfer Station. For example, does the 12-Lead Transfer Station need to dial a 1 or an area code in addition to the number? If it does, the number sent by the MRx must include these digits.	20 characters, <b>blank</b>
URL	URL for PC site type (i.e., TraceMaster or another 12-Lead Transfer Station), otherwise N/A	40 characters, <b>blank</b>
Use Hub's Routing	Indicates whether or not to use hub routing. (Note: This field is not used by the 12-Lead Transfer Station 2.0.).	<b>Yes</b> , <b>No</b>
Default Site	If yes, this will be the highlighted site when the <b>Send to</b> menu is displayed. When set to yes, this field will automatically be set to no for all other sites.	<b>Yes</b> , <b>No</b>

Table 46 Manual Therapy Settings

Parameter	Description	Setting Choices
Remain In Sync Mode After Shock	Defines whether the device remains in Sync Mode after a synchronized shock is delivered.	Yes, No
Time To Auto Disarm	Determines the amount of time the device will remain charged if a shock has not been delivered. Applies to both Manual Defib and AED Modes.	30, 60, 90 (seconds)
Pacing Rate	Upon entering the selected Pacer Mode (Demand or Fixed), defines the default rate of delivery of paced pulses.	30-180, 70 (ppm) adjusted in increments of 10
Pacing Output	Upon entering the selected Pacer Mode (Demand or Fixed), defines the default current setting at which paced pulses are delivered.	10-175, 30 (mA) adjusted in increments of 5
Manual Therapy Security	Defines whether Manual Defib and Pacer Modes are password protected.  A password entry screen is displayed when the setting is changed to <b>On</b> . Using the Menu, enter a 4-character password. Selecting <b>Cancel</b> during password entry resets the setting to <b>Off</b> . Once the password is set, changing the setting to <b>Off</b> clears the password from the device memory.	<b>Off</b> , <b>On</b> (See Warning below.)

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**WARNING** Use of the Manual Therapy Security password requires the clinician to know and remember the password, as defined in Configuration. Failure to enter the correct password will prevent the delivery of manual defibrillation or pacing therapy. Prior to selecting this Configuration option, review this potential risk with your Risk Manager.

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Table 47 AED Settings

Parameter	Description	Setting Choices
Shock Series	<p>Sets the number of shocks that must be delivered to activate an automatic CPR Pause. The length of the CPR pause is determined by the CPR Timer Setting. A new Shock Series begins when a shock is delivered:</p> <ul style="list-style-type: none"> <li>• after the device is turned on,</li> <li>• after the automatic CPR pause,</li> <li>• after the [<b>Pause for CPR</b>] soft key has been pressed, or</li> <li>• if the time since the previous shock exceeds the Protocol Timeout setting.</li> </ul>	1, 2, 3, 4
Protocol Timeout	Sets the time interval used to determine if a delivered shock should be counted as part of the shock series (see Shock Series above.)	30, <b>60</b> , 90, 120, 150, 180, 210, Off (seconds)
CPR Timer	<p>Sets the length of the pause interval that automatically starts when:</p> <ul style="list-style-type: none"> <li>• a Shock Series is completed,</li> <li>• The [<b>Pause for CPR</b>] soft key is pressed,</li> <li>• A No Shock Advised (NSA) decision is made, the NSA CPR pause is enabled, and the conditions for using the CPR Timer setting for the NSA CPR pause interval are met (see below),</li> <li>• The Shock button is not pressed for the configured “Time to Auto Disarm” setting after the device is armed in AED mode, or</li> <li>• Continuous artifact is detected during rhythm analysis.</li> </ul>	30, 60, 90, <b>120</b> , 150, 180 (seconds)
No Shock Advised (NSA) Action	<p>Defines how the device behaves following a No Shock Advised (NSA) decision:</p> <ul style="list-style-type: none"> <li>• Monitor - directs the device to monitor the patient’s ECG following an NSA decision and prompts the user to periodically perform CPR. The CPR prompt interval is defined by the Monitor Prompt interval.</li> <li>• Time Setting - directs the device to provide a CPR Pause interval following a NSA decision. If a shock has been delivered in the current Shock Series, the length of the CPR Pause interval is defined by the CPR Timer setting. Otherwise, the length of the CPR Pause interval is defined by the NSA Action time setting.</li> </ul>	Monitor, 30, 60, 90, <b>120</b> , 150, 180 (seconds)
CPR Prompt	<p>Defines the level of detail provided in the CPR reminder voice prompts provided at the completion of a Shock Series.</p> <ul style="list-style-type: none"> <li>• Long - provides detailed instruction to check airway, breathing and pulse/circulation before beginning CPR.</li> <li>• Short - provides instruction to begin CPR, if needed, only.</li> </ul>	Long, <b>Short</b>
Monitor Prompt Interval	Sets the interval for patient care prompts provided during AED monitoring of the patient’s ECG following an NSA decision. Off means there are no prompts during AED monitoring.	30, <b>60</b> , 90, 120, 150, 180, Off (seconds)

Table 48 Q-CPR Settings

Parameter	Description	Setting Choices
Deep Compression Prompt	Selects whether the prompts regarding compressions that are too deep are issued. This setting is provided to prevent unwanted voice prompts from being issued when chest compressions are performed on a patient lying on a compliant surface.	On, Off
Comp Color	Selects the color of the compression waveform and values for compression rate and no flow time.	Red, Yellow, Blue, Green, Cyan, Magenta White

Table 49 Q-CPR Data Capture Settings

Parameter	Description	Setting Choices
Q-CPR Feedback	Enables or suppresses Q-CPR feedback.	On, Off
Research Storage	Enables storage of special research data.	On, Off

Table 50 Print Settings

Parameter	Description	Setting Choices
Print on Alarm	Prints a 15 second strip (10 seconds of pre-alarm data and 5 seconds of post alarm data) when selected alarm type occurs.	Red/Yellow, Red
Print on Charge	Prints a continuous strip during charging. Printing continues until a shock is delivered, the device is disarmed, or the Print button is pressed.	Yes, No
Print on Shock	Prints a 12 second strip when a shock is delivered or when a shock is attempted but unable to be delivered.	Yes, No
Print on Mark	Prints a strip when the Mark Event button is pressed. The strip includes the printer delay (if configured) and extends 6 seconds from the start of the annotation text or from the time the Events menu is removed from the display.	Yes, No
Printer Delay	Defines whether printed strips, including those requested manually and those generated by an event (mark, charge, or shock), include an additional 10 seconds of information - the 10 seconds occurring just prior to printing being initiated.	No Delay, 10 sec.
Event Summary Report	Selects the Event Summary Report format. Short includes a log of events and vitals. Medium adds waveforms. Long adds 12-Lead Reports.	Short, Medium, Long
Strip Print Speed	Selects the ECG strip print speed.	25, 50 (mm/sec)
12-Lead Print Speed	Selects the 12-Lead ECG Report print speed.	25, 50 (mm/sec)

Table 51 Mark Event Settings

Parameter	Description	Setting Choices
Mark Event 1	Defines menu choice #1 on the Mark Events menu.	20 characters, <b>ET Access</b>
Mark Event 2	Defines menu choice #2 on the Mark Events menu.	20 characters, <b>IV Access</b>
Mark Event 3	Defines menu choice #3 on the Mark Events menu.	20 characters, <b>Adrenaline</b> (for Europe), <b>Epinephrine</b> (for the rest of the world)
Mark Event 4	Defines menu choice #4 on the Mark Events menu.	20 characters, <b>Lidocaine</b>
Mark Event 5	Defines menu choice #5 on the Mark Events menu.	20 characters, <b>Atropine</b>
Mark Event 6	Defines menu choice #6 on the Mark Events menu.	20 characters, <b>Morphine</b>
Mark Event 7	Defines menu choice #7 on the Mark Events menu.	20 characters, <b>Nitroglycerin</b>
Mark Event 8	Defines menu choice #8 on the Mark Events menu.	20 characters, <b>Aspirin</b>




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

# Data Management

This chapter describes the data management features of the HeartStart MRx.

## Overview

The HeartStart MRx automatically creates an Event Summary for each patient incident. Each Event Summary is assigned a unique event identification number and is date/time stamped. Measurements are stored for viewing, reporting and printing in the Vital Signs Trending Report. Event Summaries, including any trending and associated 12-Lead reports, are automatically stored in internal memory. When internal memory reaches capacity, with each addition of an Event Summary to internal memory, the oldest Event Summary is subsequently deleted. The current or most recent Event Summary or Vital Signs Trending report may be printed by pressing the  button. Event Summaries stored in internal memory may be individually selected and printed. Event Summaries may be selected and copied to a data card using the **Data Management** menu.

New Event Summaries are initiated each time one of the following activities occurs:


- The arrival of a valid ECG signal.
- The arrival of valid SpO<sub>2</sub> data.
- The arrival of valid CO<sub>2</sub> data.
- The arrival of valid invasive pressure data.
- The arrival of valid temperature data.
- An NBP measurement is requested.
- The Charge 2 button is pressed.
- The Mark Event  button is pressed.

The amount of patient data collected, including two ECG waveforms, two invasive pressure waveforms and one CO<sub>2</sub> waveform, and other clinical events, is determined by the amount of internal memory available. The number of incidents stored in memory at any given time is determined by the length of each incident and the amount of data collected. There is 12-hour data limit per incident with a maximum capacity of 55 patient incidents, regardless of card capacity or size of incidents. When deleting, records are erased oldest first.

**NOTE** Monitoring and defibrillation functions are disabled while using the data management features of the HeartStart MRx. An active patient incident is closed upon entering Data Management.

## Copying from Internal Memory


To copy Event Summaries and 12-Lead ECG Reports stored in internal memory to a data card:

- 1 Insert a data card, see “Installing the Data Card” on page 46.
- 2 Turn the Therapy Knob to either **Monitor**, **Pacer** or **Manual Defib**.
- 3 Press the Menu Select  button.
- 4 Using the Navigation buttons, select **Other** and press the Menu Select button.
- 5 Select **Data Management** and press the Menu Select button.
- 6 Press the Menu Select button to acknowledge the message, **Leaving Normal Operational Mode**.
- 7 Use the [**Prev Item**] and [**Next Item**] soft keys to select an Event Summary.
- 8 Press the Menu Select button to display the Data Management menu.
- 9 Select **Copy** and press the Menu Select button. The message, **Copying Patient Data**, is displayed while the Event Summary and any 12-Lead Reports are copied to the data card.

**NOTE** Do not remove the external data card from the HeartStart MRx while the device is copying 12-lead reports.

## Viewing and Erasing the Data Card

The contents and status of your data card are conveniently available for viewing. To display data card information:



- 1 Turn the Therapy Knob to either **Monitor**, **Pacer** or **Manual Defib**.
- 2 Press the Menu Select  button.
- 3 Using the Navigation buttons, select the **Other** menu and press the Menu Select button.
- 4 Select **Data Management** and press the Menu Select button.
- 5 Press the Menu Select button to acknowledge the message, **Leaving Normal Operational Mode**.
- 6 Press the Menu Select button to display the Data Management menu.
- 7 Select **View Data Card** and press the Menu Select button.

[**Prev Page**] and [**Next Page**] soft keys appear to navigate to additional display pages.

Use the **Erase Card** menu entry to delete the contents of the data card.



## Printing the Event Summary


You can print the current Event Summary at any time during the event by pressing the Summary  button and selecting **Event Summary** from the menu. If an event is not in progress, pressing the Summary  button and selecting **Event Summary** prints the most recent Event Summary. The printed format of the Event Summary is defined in Configuration.

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**WARNING** Should an alarm condition occur while an Event Summary is printing, an alarm strip is not printed. However, the corresponding ECG waveform is stored and available in the Event Summary.

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To select and print an Event Summary after an event:

- 1 Turn the Therapy Knob to either **Monitor**, **Pacer** or **Manual Defib**.
- 2 Press the Menu Select  button.
- 3 Using the Navigation buttons, select the **Other** menu and press the Menu Select button.
- 4 Select **Data Management** and press the Menu Select button.
- 5 Press the Menu Select button to acknowledge the message, **Leaving Normal Operational Mode**.
- 6 Use the soft keys labeled **[Prev Item]** and **[Next Item]** to select the Event Summary you want to print.
- 7 Press the Menu Select button to display the Data Management menu.
- 8 Select **Print** and press the Menu Select button.
- 9 Using the Navigation buttons, select **Event Summary** from the menu and press the Menu Select button. The Event Summary is printed using the configured format.

To print an Event Summary stored on the removable data card, the information must first be downloaded to the HeartStart Event Review Pro data management system. Refer to the *HeartStart Event Review Pro Instructions for Use* for download instructions.

## Printing the Vital Signs Trending Report

You can print the current Vital Signs Trending Report at any time during the event by pressing the Summary ⓘ button and selecting **Trends** and then a **Trends Interval** from the menu or by hitting the soft key under the [**Print Trends**] label.

If an event is not in progress, pressing the Summary ⓘ button and selecting **Trends** and then a **Trends Interval** prints the most recent Vital Signs Trending Report.

To select and print a Vital Signs Trending Report after an event:

- 1 Turn the Therapy Knob to either **Monitor**, **Pacer** or **Manual Defib**.
- 2 Press the Menu Select ⓪ button.
- 3 Using the Navigation buttons, select the **Other** menu and press the Menu Select button.
- 4 Select **Data Management** and press the Menu Select button.
- 5 Press the Menu Select button to acknowledge the message, **Leaving Normal Operational Mode**.
- 6 Use the soft keys labeled [**Prev Item**] and [**Next Item**] to select the Vital Signs Trending Report you want to print.
- 7 Press the Menu Select button to display the Data Management menu.
- 8 Select **Print** and press the Menu Select button.
- 9 Using the Navigation buttons, select **Trends** from the menu and press the Menu Select button. The Vital Signs Trending Report is printed using the configured format.

## Printing the 12-Lead ECG Report

You can print individual 12-Lead ECG Reports for the current or most recent patient event through the 12-Lead Report View menu. See Chapter 14 on 12-Lead Transmission.

## Events Recorded

The following events and related information are stored in the Event Summary. *Italicized* text in logged events is replaced by an appropriate value or selected option.

**Table 52 Event Information**

Logged Event	Frequency
<b>Power On/Off</b>	
Device On	Logged when device first turns on.
Device Off	Logged when Therapy Knob is turned to Off position.
Continued Use	Logged when device is turned on after being turned off for less than 10 seconds.
<b>Mode</b>	
AED Mode	Logged at start of incident and when mode or selected energy changes.
Monitor Mode	
Pacer Mode	
Selected Energy <i>xx J</i>	
Return To Owner Display	Logged when Return To Owner screen is displayed.
<b>Patient Info</b>	
Adult Patient/ Pediatric Patient	Logged at start of incident and when changed.
Paced Patient/ Non-Paced Patient	Logged at start of incident and when changed.
Age <i>xx unit</i>	Logged when set.
Male/Female	Logged when set.
Patient ID	Logged when set.
<b>Battery Status</b>	
Battery Low	Logged when batteries are low and external power is not available.
***Batteries Low	Logged when batteries are low and device is pacing.
Shutting Down in 1 Minute	Logged when warning issued.
Shutting Down Now	
<b>Pads/Paddles/Leads</b>	
Pads On	Logged when pads are applied to patient.
Pads Off	Logged after a Pads On event if adult/pediatric multifunction electrode pads are removed from the patient or the pads cable is disconnected.
External Paddles On	Logged when external paddles make contact with the patient.
External Paddles Off	Logged after an External Paddles On event if paddles lose contact with patient.
Internal Paddles On	Logged when internal paddles make contact with the patient.
Internal Paddles Off	Logged after an Internal Paddles On event if paddles lose contact with patient.
Leads On	Logged when monitoring electrodes for primary ECG are attached to the patient.
Leads Off	Logged after a Leads On event if a monitoring electrode for the primary wave loses contact with the patient.

Table 52 Event Information

Logged Event	Frequency
<b>Measurements</b>	
PVC/min Limit	Logged when device is turned on if ECG alarms are on, when settings are changed, or when ECG alarms are turned on.
VTACH Limits HR <i>value Run value</i>	
ECG Alarms Off	Logged when ECG alarms are turned off.
Primary ECG <i>label</i>	Logged for initial or change in primary ECG source.
Gain $xY$	Logged for initial or change in ECG gain.
Learning Rhythm	Logged when ST/AR algorithm learns ECG rhythm.
SpO <sub>2</sub> On/Off EtCO <sub>2</sub> On/Off <i>Pressure Label</i> On/Off <i>Temperature Label</i> On/Off	Logged when device is turned on if measurement is connected and subsequently when measurement is disconnected/connected.
HR Limits <i>low high</i> SpO <sub>2</sub> Limits <i>low high</i> EtCO <sub>2</sub> Limits <i>low high</i> <i>Pressure Label</i> Limits <i>source low high</i> <i>Temperature Label</i> Limits <i>low high</i> AwRR Limits <i>low high</i> Pulse Limits <i>low high</i>	Logged with measurement on event if measurement alarms are on, when settings are changed, or when measurement alarms are turned on.
SpO <sub>2</sub> Alarms Off EtCO <sub>2</sub> Alarms Off <i>Pressure Label</i> Alarms Off <i>Temperature Label</i> Alarms Off Pulse Alarms Off AwRR Alarms Off	Logged when measurement alarms are turned off.
Apnea Time <i>limit</i> sec.	Logged when AwRR alarms are turned on and EtCO <sub>2</sub> when settings are changed.
Pulse Alarms Off	Logged when Pulse alarms are turned off.
[Press 1 - Press 2] Label: <i>Pressure Label</i>	Logged when a pressure label is set or changed.
<i>Pressure Label</i> zeroed	Logged when <i>pressure label</i> is zeroed.
<i>Pressure Label</i> cal factor <i>value</i>	Logged when cal factor for <i>pressure label</i> is entered or a mercury calibration is completed.
Pulse Source <i>source</i>	Logged when the pulse source is initially determined and when changed.
NBP Schedule [ <i>Manual, q1, ...</i> ]	Logged when schedule is changed.
NBP On	Logged when Start NBP is initially pressed manually, or configured schedule.
NBP Limits <i>source low high</i>	Logged when Start NBP soft key pressed and when settings are changed.
NBP Alarms Off	Logged when NBP alarms are turned off.

Table 52 Event Information

Logged Event	Frequency
[Temperature] Label: <i>Temperature Label</i>	Logged when a temperature label is set or changed.
<b>Alarms</b>	
<i>**yellow or ***red alarm</i>	Logged when alarm condition occurs.
Alarms Paused	Logged when action occurs.
Alarms Resumed	Logged when action occurs.
Alarms Off	Logged when action occurs.
Audio Paused	Logged when action occurs.
Audio Resumed	Logged when action occurs.


Table 52 Event Information

Logged Event	Frequency
INOPs	See Chapter 20 for information regarding INOP statements.
<b>Defibrillation</b>	
Charging to <i>xx</i> J	Logged when device starts charging to selected energy setting.
Disarm [ <i>Manual, Auto</i> ]	Logged when device disarmed by user or automatically after time-out period.
Shock # <i>x</i>	Logged when discharge to patient (energy delivered, impedance and peak current are stored with the waveform).
No Shock Delivered	Logged when discharge to patient fails.
Sync On	Logged when Sync function turned on by user.
Sync Off	Logged when Sync function turned off by user.
<b>AED Mode</b>	
Pause/Resume	Logged when the [ <b>Pause for CPR</b> ] or [ <b>Resume Analyzing</b> ] soft keys are pressed.
Analyzing	Logged when advisory algorithm begins analysis.
Artifact Detected	Logged when advisory algorithm detects noise or motion artifact.
Auto Disarm	Logged when HeartStart MRx is automatically disarmed.
Cannot Analyze ECG	Logged when advisory algorithm cannot complete analysis sequence.
No Shock Advised	Logged when a non-shockable rhythm is detected.
Shock Advised	Logged when a shockable rhythm is detected.
<b>Pacer</b>	
Pacer Mode [ <i>Demand, Fixed</i> ]	Logged when pacing is started and when mode is changed.
Pacer [ <i>Start or Resume</i> ] <i>xx ppm xx mA</i>	Logged when pacing is started and when pacing is resumed.
Pacer Rate <i>xx ppm</i>	Logged when rate or output is changed and maintained for 2 seconds while pacing. The logged time will be the time the setting took effect. If this event is logged out of order, a * will be appended to the time stamp.
Pacer Output <i>xx mA</i>	
Pacer Pause/Stop	Logged when the Therapy Knob is moved off the Pacer position while pacing.
<b>12-Lead</b>	
12-Lead Acquired	Logged when action occurs.
12-Lead Printed <i>date/time</i>	Logged when action occurs.
12-Lead Deleted <i>date/time</i>	Logged when action occurs.
12-Lead Transmitted <i>date/time</i>	Logged when 12-Lead Report is successfully transmitted from the MRx.
<b>Mark Event</b>	
Mark Event	Logged when Mark Event button is pressed.
Mark <i>event/drug</i>	Logged when user selects an entry from the Mark Event menu.
<b>Print</b>	
Print Strip	Logged when Print button is pressed

Table 52 Event Information

Logged Event	Frequency
<b>Audio</b>	
Audio Recording Started	Logged when audio recording starts or resumes after being stopped.
Audio Recording Stopped	Logged when audio recording stops because of MRx mode change.
Audio Recording Full	Logged when audio recording stops because 90 minutes of audio has been recorded for the current event.
<b>Q-CPR</b>	
NOTE: Q-CPR events are logged to the patient incident record but are not included in the Event Summary report printed by the HeartStart MRx. Events and waveforms related to Q-CPR can be viewed through Q-CPR Review.	
Q-CPR feedback On	Logged at the beginning of an event if the Q-CPR Feedback configuration setting is On.
Q-CPR feedback Off	Logged at the beginning of an event if the Q-CPR Feedback configuration setting is Off.
Cannot Analyze Vent	Caused by ventilation events (either spontaneous respiration or noise) with an impedance change > 3 ohms.
PCI Clear All	Logged when PCI INOP conditions are cleared. For example, Cannot Analyze Vent.
Pads Off	Pads are off the patient while Q-CPR is active (ventilation invalid).
Poor Pads Contact	Pads are on the patient but the impedance is >140 ohms while Q-CPR is active.
CPR Sensor Inverted	Compression sensor is upside down.
CPR Sensor Malfunction	Compression sensor responds with an error.
CPR Sensor Unplugged	Device cannot communicate with the compression sensor.


## Marking Events



The Mark Event  button allows you to annotate the Event Summary and the ECG strip at the point in time the button is pressed. If configured, pressing the Mark Event button prints a 6-second ECG strip. Depending on configuration, the ECG strip is either printed real time, or prepended with the previous 10 seconds of data leading up to the marked event.

Once pressed, the Mark Event label in the upper left corner of the display changes to Select Event and the Mark Events menu is displayed (see Figure 83).

**Figure 83** Mark Events Menu

Mark Events
ET Access
IV Access
<b>Epinephrine</b>
Lidocaine
Atropine
Morphine
Nitroglycerin
Aspirin
Other

Use the Navigation buttons to select the desired event and press the Menu Select  button.

The ECG strip is annotated with the mark event  symbol and the selected annotation. If an annotation item is not selected within five seconds after the Mark Event button is pressed, only the generic mark event  symbol will appear on the ECG strip.

The marked event is stored in the Event Summary.

**NOTE** Entries on the Mark Events menu are as configured. Changes are made using the Configuration menu.



## Printing Events

The HeartStart MRx can be configured to print automatically when certain events occur. Table 53 lists these events and the length of the strip printed, depending on whether the printer is configured to print real-time or with a 10-second delay.

**Table 53 Printed Strip Lengths**

Event	Real-Time Strip Length	Delayed Strip Length
HeartStart MRx charges to deliver a shock.	Continuous	10 seconds just prior to charging, plus continuous printing through the charge duration.
Shock delivered	12 seconds	10 seconds just prior to shock, plus 12 seconds after shock.
Shock failed	12 seconds	10 seconds just prior to the message <b>No Shock Delivered</b> , plus 12 seconds after the message.
Alarm condition	15 seconds (10 seconds of pre-alarm data and 5 seconds of post alarm data when specified alarm type occurs.	Same as real-time strip.
Mark Event ► button pressed	6 seconds from the start of the annotation text or from the time the Events menu is removed from the display.	10 seconds prior to the Mark Event plus 6 seconds from the start of the annotation text or from the time the Events menu is removed from the display.



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# Maintenance

This chapter describes how to care for your HeartStart MRx and its accessories.

## Overview

Proper maintenance of the HeartStart MRx is a very simple, yet important factor in dependability. It involves:

- Providing power so automated tests can be run
- Observing the Ready For Use (RFU) indicator
- Performing the Operational Check
- Caring for batteries
- Cleaning the device and accessories
- Ordering replacement supplies and accessories

---

**WARNING** Electric shock hazards exist internally. Do not remove assembly screws. HeartStart MRx service should only be performed by qualified service personnel, in accordance with the *HeartStart MRx Service Manual*.

---

**NOTE** Calibration of the optional end-tidal CO<sub>2</sub> and noninvasive blood pressure modules of the HeartStart MRx needs to be performed yearly by a qualified service provider, as described in the *HeartStart MRx Service Manual*.

## Automated Tests

The HeartStart MRx independently performs many maintenance activities, 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 Ready For Use indicator and the Automated Test Summary report. Results are also reported through INOP statements on the display when the HeartStart MRx is turned on. Table 54 provides a brief explanation of the tests and lists the frequency with which each is performed.


**Table 54 Automated Tests**

Test Name	Description	Frequency
Hourly	Tests batteries, internal power supplies and internal memory.	Hourly
Daily	Tests batteries, internal power supplies, internal memory, internal clock battery, defibrillation, pacing, ECG, SpO <sub>2</sub> , EtCO <sub>2</sub> , NBP, Invasive Pressure, Temperature, Bluetooth and printer. The defibrillation test includes low energy internal discharges. If a 3-, 5-, or 10-lead ECG cable is attached, the cable is tested as well.	Daily, between 11 pm and 1 am
Weekly	Performs the Daily Test described above, plus delivers a high energy internal discharge to further exercise the defibrillation circuitry.	Weekly, between 11PM Sunday and 1 AM Monday

**NOTE** Automated tests do not test therapy cables, paddles, buttons, audio, or the display. An ECG cable is tested, if connected at the time of the test.

## Automated Test Summary

An Automated Test Summary (ATS), showing the results of recent tests, may be printed as evidence that the HeartStart MRx is tested regularly. To display the ATS and print its results:

- 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 **Automated Test Summary** and press the Menu Select button. The Automated Test Summary is displayed.

The message, **Leaving Normal Operating Mode**, appears to let you know that you are exiting from clinical functionality of the monitor/defibrillator.

- 6 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 55.

**Table 55 Automated Test Summary Results**

Result	RFU Indicator	Definition	Required Action
Pass	Hourglass	All tests passed	None
Fail/DX	Solid red X, chirp	A problem has been detected that may prevent the delivery of a shock, pacing, or ECG acquisition.	Turn the Therapy Knob to Monitor. An inop indicating a problem has occurred is displayed. Refer to Chapter 20, Troubleshooting, for the action to take.
Fail/BF	Blinking X	The total battery capacity (combination of both batteries) is less than 20%.	Charge the battery as soon as possible and/or replace the battery with a charged battery. Charging may be done in the HeartStart MRx or by connecting to AC/DC power, or in a Philips-approved battery support system.
Fail/D	Hourglass	A problem has been detected with a component that does not affect therapy delivery.	Turn the Therapy Knob to Monitor. An inop indicating the failed component is displayed. Refer to Chapter 20, Troubleshooting, for the action to take.

## Ready For Use Indicator

The results from Automated Tests are reported through the Ready For Use (RFU) indicator. Be sure to observe the RFU indicator periodically and take the appropriate action, as described in Table 56.

**Table 56 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" with or without a periodic chirp	Low battery. The device can be used but run time is limited. Chirping indicates the battery is not being charged. No chirping indicates the battery is being charged.	Charge the battery as soon as possible and/or replace the battery with a charged battery. Charging may be done in the HeartStart MRx by connecting to AC/DC power, or in a Philips-approved battery support system
Solid red "X" and a periodic chirp	A failure has been detected that may prevent the delivery of a shock, pacing, or ECG acquisition.	Turn the Therapy Knob to <b>Monitor</b> . An inop message describing the failure is displayed. See Chapter 20, Troubleshooting, for the corrective action. If needed, run an Operational Check for further information. If the condition persists, take the device out of use and call for service.
Solid red "X" without a periodic chirp	No power, or device failure (cannot turn on).	Insert a charged battery or connect to AC/DC power. If the condition persists, take the device out of use and call for service.

**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. This does not indicate a failure of the device.

# Shift Checklist

In order to ensure defibrillators are ready when needed, the American Heart Association (AHA) recommends that users complete a checklist, often referred to as a shift check, at the beginning of each change in personnel. The activities on this check list include verifying that the appropriate supplies and accessories are present, the device is plugged in and has sufficient battery power, and the device is ready for use. Philips Medical Systems supports the AHA checklist recommendations and has provided a Shift Checklist document with the device and published a copy in this book. See the “HeartStart MRx Shift Checklist” on page 220.

## Weekly Shock Test

In addition to the shift check, you must verify the ability to deliver defibrillation therapy once a week by performing one of the following:

- Operational Check
- Weekly Shock Test (See following instructions.)

**NOTE** Test reusable sterilizable paddles (internal or external) prior to each use. See the *Sterilizable Defibrillator Paddles Instructions for Use* for more information.

**To perform the Weekly Shock test:**

- 1 If you are using paddles, make sure the paddles are secure in their pockets and that the Patient Contact Indicator (PCI) LEDs located on the sternum paddle are not lit. If the LEDs light, adjust the paddles in their pockets. If the LEDs continue to light, clean both the adult and pediatric paddle electrode surfaces.  
or  
If you are using multifunction electrode pads, attach a test load to the end of the patient Therapy cable.
- 2 Turn the Therapy knob to 150J.
- 3 Press the Charge button.

**NOTE** If it becomes necessary to disarm the defibrillator, press **[Disarm]**.

- 4 The strip prints if configured to do so. If the strip does not print immediately, press the Print button.
- 5 If using:
  - Pads, press the Shock button on the MRx to deliver a shock into the test load.
  - External paddles, simultaneously press the shock buttons located on the paddles to deliver a shock into the pockets.
- 6 Confirm on the printed strip that the energy delivered to the test load is  $150\text{J} \pm 23\text{J}$  (127J to 173J). If not, take the device out of use and begin troubleshooting.

### HeartStart MRx Shift Checklist

Inspect the MRx, accessories, and supplies at the change of every shift, per AHA guidelines. Place a check mark in the box as you check each item in the list below or place a dash (-) or N/A if not applicable. Then, initial the list to indicate the check was performed for that shift.

Device Name or Serial Number: \_\_\_\_\_ Unit or Department: \_\_\_\_\_

Date:															
Shift:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
RFU Indicator - Hourglass If <b>blinking X</b> - Plug into AC/DC power or insert charged battery If <b>solid X</b> - Insert charged battery or AC/DC power. If condition persists, call for service															
Cables/connectors - present and inspected															
Paddles/Therapy cable - present and inspected															
Pads Present, sufficient supply _____															
Compression Sensor and Adhesive Pads _____															
Monitoring Electrodes - present, sufficient supply _____															
Charged Batteries - one in device, spares _____															
AC/DC Power Cord - plugged in, green light on															
Printer Paper - present, sufficient supply _____															
Data Card present, sufficient supply _____															
SpO <sub>2</sub> Sensors - present, sufficient supply _____															
NBP cuffs/tubing - present, sufficient supply _____															
CO <sub>2</sub> FilterLine - present, sufficient supply _____															
Invasive Pressure Transducers - present and inspected															
Temperature Sensors - present and inspected															
Initials															



**Shift Checklist (page 2)****HeartStart MRx Weekly Shock Test**

Do one of the following at least once a week to verify the ability to deliver defibrillation therapy:

Operational check (See *Instructions for Use* for details)

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Deliver a 150J shock into a test load (See instructions below)

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Note:** If the HeartStart MRx has Software Release B.05 or greater with the Pacing option, you cannot test external paddles through Operational Check. Perform the Weekly Shock Test to test the external paddles. Additionally, test reusable sterilizable paddles (internal or external) prior to each use. See the *Sterilizable Defibrillator Paddles Instructions for Use*.

**How to Perform the Weekly Shock Test:**

Test each type of patient therapy cable used (multifunction electrode pads or paddles).

- 1 If you are using paddles, make sure the paddles are secure in their pockets and that the Patient Contact Indicator (PCI) LEDs located on the sternum paddle are not lit. If the LEDs light, adjust the paddles in their pockets. If the LEDs continue to light, clean both the adult and pediatric paddle electrode surfaces.  
OR  
If you are using multifunction electrode pads, attach a test load to the end of the patient Therapy cable.
- 2 Turn the Therapy Knob to 150J.
- 3 Press the Charge button. NOTE: If it becomes necessary to disarm the defibrillator, press **[Disarm]**.
- 4 The strip prints if configured to do so. If the strip does not print immediately, press the Print button.
- 5 If using:
  - Pads, press the Shock button on the HeartStart MRx to deliver a shock into the test load.
  - External paddles, simultaneously press the shock buttons located on the paddles to deliver a shock into the test load.
- 6 Confirm on the printed strip that the energy delivered to the test load is 150J + 23J (127J to 173J). If not, take the device out of use and call for service.

**What Gets Tested in an Operational Check**

Operational Checks supplement the Automated Tests by verifying therapy cables, the ECG cable, paddles, audio, charge and shock buttons and the ability to deliver defibrillation and pacing therapy. Operational Checks also notify you if the battery, NBP module, or CO<sub>2</sub> module needs calibration and checks the SpO<sub>2</sub> module, printer, and Compression Sensor. If you choose to perform the weekly shock test in lieu of the Operational Check, you need to ensure the ECG cable, pacing functions, audio, battery calibration, NBP and CO<sub>2</sub> calibration, CO<sub>2</sub> and SpO<sub>2</sub> modules, temperature, Bluetooth, invasive pressures, printer, and Compression Sensor are checked periodically. The best way to do this is through an Operational Check. It is recommended that you establish a schedule for conducting periodic Operational Checks.

# Operational Check

Operational Checks should be performed at regular intervals to supplement the hourly, daily, and weekly Automated Tests executed by the MRx. Automated Tests provide adequate assurance that the device is in a functional state of readiness. Operational Checks supplement the Automated Tests by verifying therapy cables, the ECG cable, paddles, audio, the Charge and Shock buttons, Therapy Knob, and Compression Sensor, along with replicating the Weekly test. Operational Checks also notify you if the battery, NBP module, or CO<sub>2</sub> module need calibration.

---

**WARNING** Be sure the HeartStart MRx is not connected to the patient when performing an Operational Check.

---

**NOTE** It is important to establish a schedule for conducting Operational Checks, as well as for checking supplies and accessories associated with the HeartStart MRx. This will ensure that the device is ready to monitor and deliver therapy. The Operational Check is run with a battery installed to reflect optimal operating conditions for defibrillation. The device automatically disconnects AC/DC power.

**NOTE** If you have the Pacing option, test external paddles using the Weekly Shock test. You must run Operational Check with a pads cable in order to pass the Pacer test.

Prior to performing the Operational Check, ensure that the paddles (if tested) are secure in their pockets and that the PCI LEDs are not lit. Should the LEDs light, adjust the paddles in their pockets. If the LEDs continue to light, clean both the adult and pediatric paddle electrode surfaces.

At completion of the Operational 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 severity of the failed functionality:


- Service device.
- Replace battery.
- Replace Compression Sensor.
- Replace Pads cable.
- Replace Paddles cable.
- Replace Therapy cable.
- Replace ECG cable

You must fix the problem and successfully run the Operational Check to clear the failure.

**NOTE** If the HeartStart MRx is equipped with multifunction defib pads only and does not have a paddle tray, you cannot test paddles during an Operational Check. To test paddles, you **must** have a test load. Run the Weekly Shock Test, delivering the shock into the test load. See “Weekly Shock Test” on page 219.

## Performing the Operational Check

To perform the Operational Check:

- 1 Insert a charged battery (capacity of 20% or greater).
- 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 Operational Check** and press the Menu Select button.  
The message window, **Leaving Normal Operating Mode**, appears to let you know that you are exiting from clinical functionality and entering a test mode of the monitor/defibrillator.
- 7 Press the Menu Select button to acknowledge the message.

### Operational Check Setup

Carefully read the setup instructions on the screen. Once the HeartStart MRx is set up properly, you can proceed with the Operational Check. If the device has the Q-CPR option, you should run the Operational Check with the Pads/CPR cable and the Compression Sensor, keeping the Compression Sensor still during the test. If the HeartStart MRx has the Pacing option, you must run the Operational Check with a Pads cable.

---

**WARNING** Be sure to safely discharge internal and external paddles tested during the Operational Check.

---

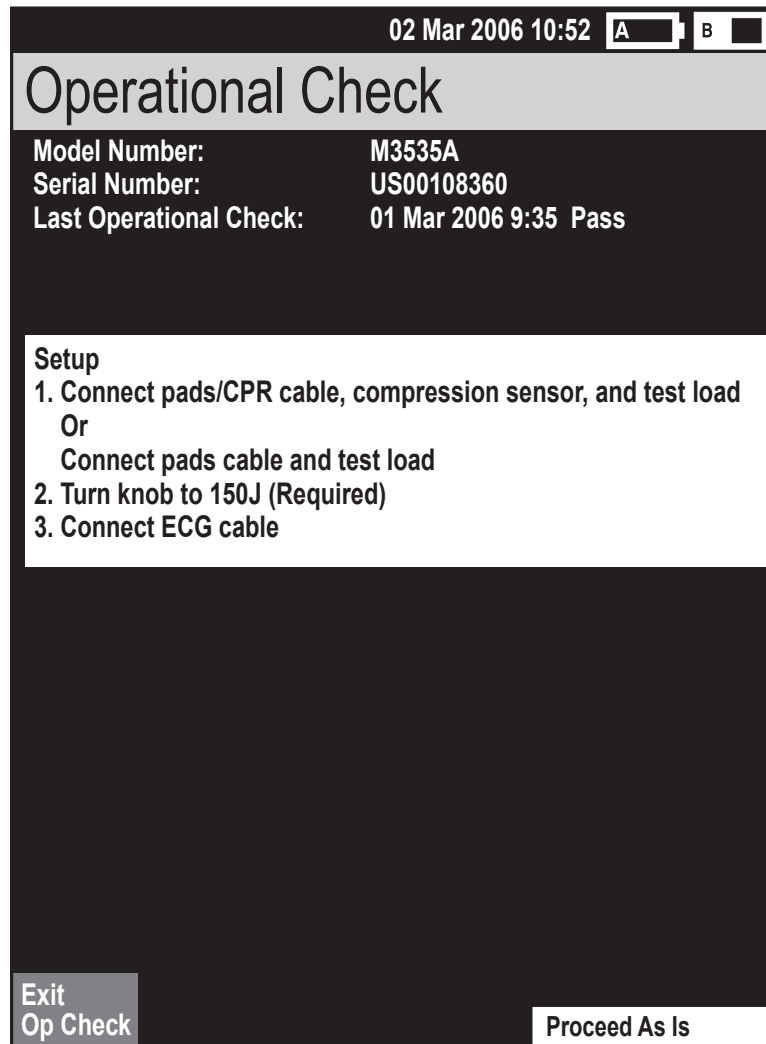
**NOTE** If you choose to proceed without setting up properly, the Operational Check may fail.

When a response is required, use the Navigation buttons to select your answer and the Menu Select button to confirm your choice. Table 57 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).

As each test is run, the name of the test appears on the display with the message **In Progress**, as shown in Figure 85.

Once you have answered the last prompt (Audio test), you can leave the HeartStart MRx unattended and the Operational Check will complete. If you cancel the Operational Check before it completes, there is no record of it in the Operational Check Summary.

Figure 84 Operational Check Setup Screen



02 Mar 2006 10:52 A B

## Operational Check

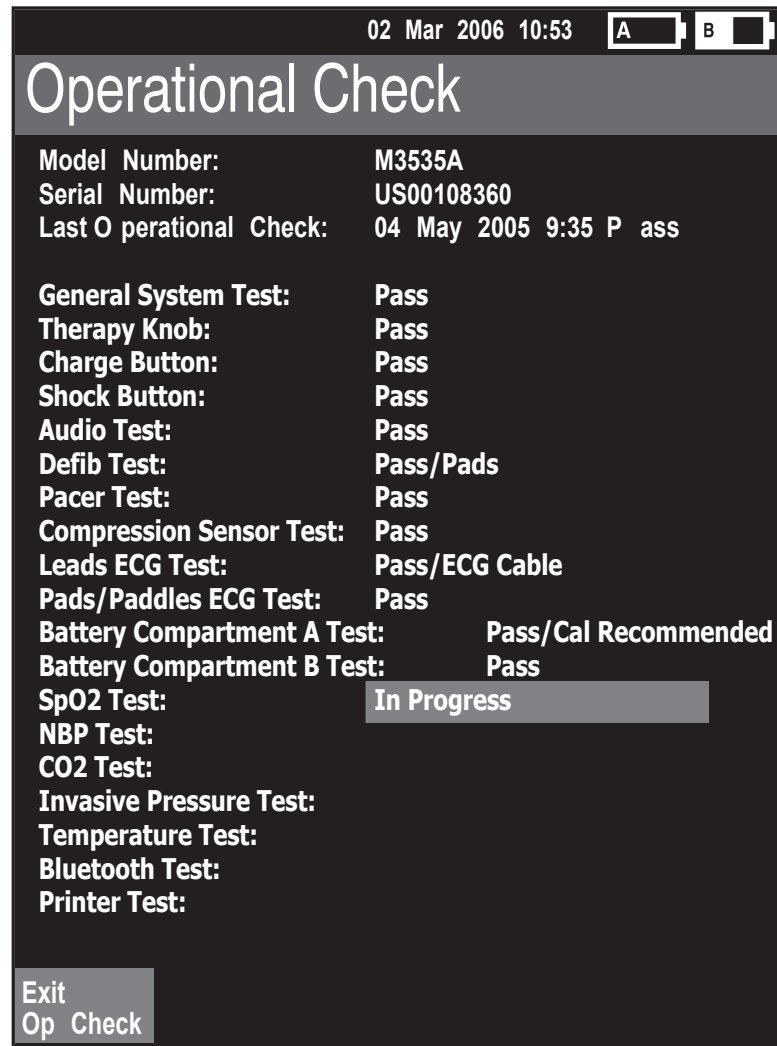
Model Number: M3535A  
Serial Number: US00108360  
Last Operational Check: 01 Mar 2006 9:35 Pass

**Setup**

1. Connect pads/CPR cable, compression sensor, and test load  
Or  
Connect pads cable and test load
2. Turn knob to 150J (Required)
3. Connect ECG cable

Exit Op Check Proceed As Is

Figure 85 Operational Check Screen



02 Mar 2006 10:53 A B

# Operational Check

Model Number: M3535A  
Serial Number: US00108360  
Last Operational Check: 04 May 2005 9:35 P ass

General System Test: Pass  
Therapy Knob: Pass  
Charge Button: Pass  
Shock Button: Pass  
Audio Test: Pass  
Defib Test: Pass/Pads  
Pacer Test: Pass  
Compression Sensor Test: Pass  
Leads ECG Test: Pass/ECG Cable  
Pads/Paddles ECG Test: Pass  
Battery Compartment A Test: Pass/Cal Recommended  
Battery Compartment B Test: Pass  
SpO2 Test: In Progress  
NBP Test:  
CO2 Test:  
Invasive Pressure Test:  
Temperature Test:  
Bluetooth Test:  
Printer Test:

Exit  
Op Check

Table 57 Operational Checks Test

Test	Description	Prompts	Action
General System	Tests internal clock battery, power supply, and internal memory card.	None.	None.
Therapy Knob	Tests if the Therapy Knob is set to 150J.	None.	None.
Charge Button	Tests the Charge button.	<p>Depending on the cable connected, as follows:</p> <ul style="list-style-type: none"> <li>If the Pads cable is attached, you are prompted to, <b>Verify Test Load is Attached and Press the Charge Button.</b></li> <li>If external paddles are attached, you are prompted to, <b>Verify Paddles are in Holders and Press the Charge Button.</b></li> <li>If no cable is attached, the test is marked Not Tested.</li> </ul> <p>If the MRx does not detect a press of the Charge button within 10 seconds the message <b>If the Charge button does not work, select Charge from the menu below</b> is displayed.</p>	<p>Respond to the prompt, as follows:</p> <ul style="list-style-type: none"> <li>Check the test load is attached and press the Charge button.</li> <li>Make sure the paddles are seated in their pockets and press the Charge button.</li> </ul> <p>If the Charge button is not working, press <b>Charge</b> from the No Button Response menu. The Charge button test is marked Fail and the Operational Check fails.</p>
Shock Button	Tests the Shock button.	<ul style="list-style-type: none"> <li>Once charged the Shock button lights and you are prompted to, <b>Press Shock or Press Shock buttons on paddles.</b></li> <li>If the MRx does not detect a press of the Shock button within 10 seconds the message <b>If the Shock button does not work, select Shock from the menu below</b> is displayed.</li> </ul> <p>Note: The device automatically disarms after the time specified in the configuration is reached.</p> <ul style="list-style-type: none"> <li>The message <b>Defib Disarmed</b> is displayed.</li> </ul>	<ul style="list-style-type: none"> <li>Press the Shock button.</li> <li>If the Shock button is not working, press <b>Shock</b> from the No Button Response menu. The Shock button test is marked Fail.</li> <li>Select <b>Shock</b> from the menu to continue the Operational Check or press <b>Exit Op Check</b>. The Shock button test is marked Fail.</li> </ul>

Table 57 Operational Checks Test (Continued)

Test	Description	Prompts	Action
Audio	<p>If a shock was delivered during the Shock test, the voice prompt, <b>Shock Delivered</b> is annunciated.</p> <p>If no shock was delivered during the Shock test, the voice prompt <b>No Shock Delivered</b> is annunciated.</p>	<b>Did you hear Shock/No Shock Delivered?</b>	Use the navigation buttons to respond <b>Yes</b> or <b>No</b> . Then press the Menu Select button.
Defib	<p>Tests defibrillation circuitry and delivers a shock through:</p> <ul style="list-style-type: none"> <li>• pads, into a test load,</li> </ul> <p>and/or</p> <ul style="list-style-type: none"> <li>• external paddles, into the MRx</li> </ul> <p>Note: The Defib test has two components: a high energy internal discharge and a low energy (5J) external discharge. The results of the device's ability to charge and shock are reported in the Defib test.</p>	None.	None.
Pacer	Tests pacing functionality and delivers a paced pulse into a 50 ohm test load.	None.	None.
Compression Sensor	Checks the basic communication circuitry of the sensor.	None.	None.
Leads ECG	Tests leads ECG acquisition and the ECG cable.	None, if test passes. If test fails the following prompt is displayed at the end of all remaining tests: <b>Leads ECG Test failed with cable. Disconnect ECG cable to rerun test without cable.</b>	<p>If the ECG test fails with the cable and passes without the cable, the ECG cable is bad. Replace the ECG cable and rerun Operational Check.</p> <p>If the ECG test fails with and without the cable, see "Troubleshooting" on page 249.</p>

Table 57 Operational Checks Test (Continued)

Test	Description	Prompts	Action
Pads/Paddles ECG	Checks ECG acquisition through pad/paddles.	None, if test passes. If test fails the following prompt is displayed at the end of all remaining tests: <b>Pads/Paddles ECG Test failed with cable. Disconnect therapy cable to rerun test without cable.</b>	If the Pads/Paddles test fails with the cable and passes without the cable, the cable is bad. Replace the Therapy cable and rerun Operational Check. If the Pads/Paddles test fails with and without the cable, see “Troubleshooting” on page 249.
Battery A Battery B	Checks the total battery capacity (combination of both batteries) and calibration status of the batteries in Compartments A and B.	None.	None.
SpO <sub>2</sub>	Checks the internal SpO <sub>2</sub> PCA. The SpO <sub>2</sub> cable is not tested.	None.	None.
NBP	Checks to see if the NBP module is functioning; determines if it is due for calibration.	None.	None.
CO <sub>2</sub>	Checks to see if the CO <sub>2</sub> module is functioning; determines if it is due for calibration.	None.	None.
Invasive Pressures	Checks to see if the invasive pressure hardware is working properly.	None.	None.
Temperature	Checks to see if the temperature hardware is working properly.	None.	None.
Bluetooth	Checks for the presence of the Bluetooth card and database integrity.	None.	None.
Printer	Runs a printer self test.	None.	None.





## User Checks

The guidelines for completing user checks are as follows:

**Defibrillator Inspection** Make sure the HeartStart MRx is clean, clear of objects, and has no visible signs of damage.

**Cables/Connectors/Paddles/Pads/Monitoring Electrodes** Make sure there are no cracks, broken wires, or other visible signs of damage. Make sure the connections are secure. Check expiration date and quantity of pads and monitoring electrodes

**Compression Sensor** Inspect the Compression Sensor and cable for visible signs of damage. If damaged, remove from use.

**Compression Sensor Adhesive Pads** Make sure there is a Compression Sensor Adhesive Pad applied to the Compression Sensor and there is an adequate supply available.

**Batteries** Make sure a charged battery is in the HeartStart MRx. Another charged battery should be available or should be charging. Ensure the batteries have no visible signs of damage.

**AC/DC Power** Check the AC/DC power source (and power cord available):

- 1 Connect the AC/DC power module to the HeartStart MRx and plug it into a power outlet.
- 2 Verify that the external power indicator on the front panel is lit.

**Printer Paper** Make sure the printer has sufficient paper and is printing properly.

**Data Card** If applicable, make sure a data card is inserted and has sufficient space available.

**SpO<sub>2</sub> Sensor** Inspect the sensor and cable for visible signs of damage.

**NBP Cuffs and Tubing** Inspect the pressure cuffs and tubing for visible signs of damage.

**CO<sub>2</sub> FilterLine** Confirm that at least one un-opened, sterile package is available.

**Invasive Pressure Cables** Inspect the cable for visible signs of damage.

**Temperature Probes** Inspect the probe and cable for visible signs of damage.

**NOTES** Upon completing the Operational Check and returning to a clinical mode (Monitor, Pacer, Manual Defib or AED), all settings will be reset to the device's configured values.

If your institution's protocol requires periodic alarm verification, and you wish to perform an alarm verification test (in a non-clinical environment) outside of the Operational Check testing, you can connect the HeartStart MRx up to a simulator, manually change the alarm limits to a setting which should cause an alarm to annunciate. Look at the display and listen for the alarm. Be sure to reset the alarm limits to the appropriate settings before returning the device to a clinical environment.

Table 58 Operational Check Test Results

Test	Results	Action if Test Does Not Pass
General System	<ul style="list-style-type: none"> <li>Pass - The clock battery, power supplies, and internal memory are functioning.</li> <li>Fail - The clock battery, power supplies, and/or internal memory are not functioning. A failure may abort the remaining tests.</li> </ul>	If the test fails with the AC/DC power module present, remove the module and repeat the test. If the test continues to fail, call for service. If the test passes, replace the power module.
Therapy Knob	<ul style="list-style-type: none"> <li>Pass - The Therapy Knob is set to 150J.</li> <li>Fail - The Therapy Knob is not set to 150J.</li> <li>Fail - The Therapy Knob is not functioning.</li> </ul>	If the test fails, confirm that the Therapy Knob is set to 150J and repeat the test. If the test continues to fail, call for service.
Charge Button	<ul style="list-style-type: none"> <li>Pass - The Charge Button passed its self-test.</li> <li>Fail - Proceed was selected from the No Button Response Menu.</li> <li>Fail - The Charge Button is not functioning.</li> </ul>	Repeat the test. If the test continues to fail because there is no response from the Charge Button, call for service.
Shock Button	<ul style="list-style-type: none"> <li>Pass - The Shock Button passed its self-test.</li> <li>Fail - Proceed was selected from the No Button Response Menu.</li> <li>Fail - The Shock Button was not pressed before the configured Auto Disarm time period ended.</li> </ul>	Repeat the test being sure to press the Shock Button before reaching the Auto Disarm time. If the test continues to fail, call for service.
Audio	<ul style="list-style-type: none"> <li>Pass - You responded <b>Yes</b>, that you were able to hear the test voice prompt.</li> <li>Fail - You responded <b>No</b>, to hearing the voice prompt.</li> </ul>	Take the device out of use and call for service.
Defib	<ul style="list-style-type: none"> <li>Pass/cable type - The defib test passed with the specified cable type (pads, external paddles) attached.</li> <li>Fail/cable type - The test failed with the specified cable type connected.</li> </ul>	If the test fails, repeat it using a different therapy cable. A passing result with a different cable indicates the previous cable is defective and should be replaced. If the test continues to fail, take the device out of use and call for service.
Pacer	<ul style="list-style-type: none"> <li>Pass - Pacing is functioning.</li> <li>Fail - Pacing is not functioning.</li> </ul>	If the pacer fails, attach a different pads cable and test load and repeat the test.  If the pacer fails again, take the device out of use and call for service.
Compression Sensor	<ul style="list-style-type: none"> <li>Pass - The Compression Sensor passed its self test.</li> <li>Fail - The Compression Sensor failed its self test.</li> </ul>	If the test fails, call for service to test the Compression Sensor. If Q-CPR is essential to patient care, take the device out of use.
Leads ECG	<ul style="list-style-type: none"> <li>Pass/ECG Cable - leads ECG acquisition and the ECG cable connected are both functioning.</li> <li>Pass/No Cable - leads ECG acquisition is functioning.</li> <li>Fail/ECG Cable- leads ECG acquisition and/or the ECG cable connected are not functioning.</li> <li>Fail/No Cable - leads ECG acquisition is not functioning.</li> </ul>	If the test fails without an ECG cable connected, take the device out of use and call for service. If the test fails with a cable, repeat the test without an ECG cable attached. A passing result without a cable attached indicates the cable is defective and should be replaced. If the test continues to fail, take the device out of use and call for service.

Table 58 Operational Check Test Results (Continued)

Test	Results	Action if Test Does Not Pass
Pads/Paddles ECG	<p>Pass/cable type - ECG acquisition and the cable are both functioning.</p> <p>Pass/No cable - ECG acquisition is functioning; a cable was not tested.</p> <p>Fail/cable type- ECG acquisition and/or the cable specified are not functioning.</p>	If the test fails with a cable connected, remove the cable and repeat the test. If the test passes without the cable, replace the cable. If the test continues to fail, take the device out of use and call for service.
Battery A Battery B	<ul style="list-style-type: none"> <li>• None - There is no battery in the slot.</li> <li>• Pass - The battery has 20% or greater capacity.</li> <li>• Fail - The battery has 20% or less capacity.</li> <li>• Cal Recommended - The battery requires calibration.</li> </ul>	<p>Charge the battery.</p> <p>Calibrate the battery.</p>
SpO <sub>2</sub>	<ul style="list-style-type: none"> <li>• Pass - SpO<sub>2</sub> passed its self-test.</li> <li>• Fail - SpO<sub>2</sub> is not functioning.</li> </ul>	If the test fails, call for service to repair the SpO <sub>2</sub> module. If SpO <sub>2</sub> monitoring is essential to patient care, take the device out of use.
NBP	<ul style="list-style-type: none"> <li>• Pass - NBP passed its self-test.</li> <li>• Fail - NBP is not functioning.</li> <li>• Pass (Cal Due) - NBP passed its self-test and is due to be calibrated.</li> <li>• Fail (Cal Overdue) - NBP passed its self-test but is overdue for calibration. Measurements may be inaccurate.</li> <li>• Fail (Replacement Recommended) - NBP passed its self-test but has exceeded 50,000 cycles.</li> </ul>	<p>If the test fails, call for service to repair the NBP module. If NBP monitoring is essential to patient care, take the device out of use.</p> <p>If calibration is due or overdue, arrange for a qualified service provider to perform the calibration.</p> <p>If replacement is recommended, call for service.</p>
CO <sub>2</sub>	<ul style="list-style-type: none"> <li>• Pass - CO<sub>2</sub> passed its self-test.</li> <li>• Fail - CO<sub>2</sub> is not functioning.</li> <li>• Pass (Cal Due) - CO<sub>2</sub> is passed its self-test and is due for calibration.</li> <li>• Fail (Cal Overdue) - CO<sub>2</sub> passed its self-test and is overdue for calibration. Measurements may be inaccurate.</li> <li>• Fail (Replacement Recommended) - CO<sub>2</sub> passed its self-test but has exceeded 15,000 operating hours.</li> </ul>	<p>If the test fails, call for service to repair the CO<sub>2</sub> module. If CO<sub>2</sub> monitoring is essential to patient care, take the device out of use.</p> <p>If calibration is due or overdue, arrange for a qualified service provider to perform the calibration.</p> <p>If replacement is recommended, call for service.</p>


Table 58 Operational Check Test Results (Continued)

Test	Results	Action if Test Does Not Pass
Invasive Pressures	<ul style="list-style-type: none"> <li>• Pass - Invasive Pressures passed its self-test.</li> <li>• Fail - Invasive Pressures is not functioning.</li> </ul>	If the test fails, call for service (to replace the Invasive Pressures/Temperature board.) If invasive pressure monitoring is essential to patient care, take the device out of use.
Temperature	<ul style="list-style-type: none"> <li>• Pass - Temperature passed its self-test.</li> <li>• Fail - Temperature failed its self-test.</li> </ul>	If the test fails, call for service (to replace the Invasive Pressure/Temperature board.) If temperature monitoring is essential to patient care, take the device out of use.
Bluetooth	<ul style="list-style-type: none"> <li>• Pass - A Bluetooth card is detected and communicating.</li> <li>• Fail - A Bluetooth card is not installed or is not functioning.</li> </ul>	If the test fails, call for service.
Printer	<ul style="list-style-type: none"> <li>• Pass - The printer passed its self-test.</li> <li>• Fail - The printer needs repair.</li> </ul>	If the test fails, call for service.

## Operational Check Summary

The Operational Check Summary lists the results from the last 60 Operational Checks. Test results are reported as described in Table 58.

To view the Operational Check Summary:

- 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 **Op Check Summary** and press the Menu Select button.
- 6 Press the Menu Select button to acknowledge the message, **Leaving Normal Operational Mode**. The Operational Check Summary screen is displayed.
- 7 Press the [**Print**] soft key to print the report.

**Table 59 Operational Check Summary Results**

Result	RFU Indicator	Definition	Required Action
Pass	Hourglass	All tests passed	None
Fail/DX	Solid red X, chirp	A problem has been detected that may prevent the delivery of a shock, pacing, or ECG acquisition.	Turn the Therapy Knob to Monitor. An inop indicating the problem is displayed. See Chapter 20, Troubleshooting, for the corrective action.
Fail/CX	Solid red X, chirp.	A problem has been detected with a cable.	Turn the Therapy Knob to Monitor. An inop indicating the failed cable is displayed. Replace the failed cable.
Fail/BF	N/A <sup>1</sup>	A battery failure was detected.	Replace the battery.
Fail/D	Hourglass	A problem has been detected with a component that does not affect therapy delivery.	Turn the Therapy Knob to Monitor. An inop indicating the failed component is displayed. See Chapter 20, Troubleshooting, for the corrective action.
Fail/S	Hourglass	Compression Sensor failure.	Check the Compression Sensor and cable connections. If necessary, replace the Compression Sensor.

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

# Battery Maintenance

Battery maintenance is essential to ensure that the battery's state of charge is accurately reported, there is sufficient charge and capacity to operate your HeartStart MRx, and battery life is optimized. Remove faulty batteries from service immediately.

Battery maintenance begins upon receipt of a new battery, and continues throughout the life of the battery. Detailed information on battery care is available in the Application Note, "*M3538A Lithium Ion Battery Characteristics and Care*", which was provided with your HeartStart MRx.

Table 60 lists battery maintenance activities and when they should be performed.

**Table 60 Battery Maintenance Procedures**

Activity	When to Perform
Perform a visual inspection.	As part of the Operational Check.
Charge the battery.	Upon receipt, after use, or if the message <b>Batteries Low</b> is displayed.
Perform a calibration.	When the Operational Check test results state <b>Calibration Recommended</b> , or every 6 months, whichever comes first.
Store batteries in a state of charge in the range of 20% - 40%	When not in use for an extended period of time.
Discard the battery.	When there are visual signs of damage or calibration reports less than 80% capacity.

## Battery Life

Battery life depends on the frequency and duration of use. When properly cared for, the M3538A Lithium Ion battery has a useful life of approximately 2 years. To optimize performance, a fully (or nearly fully) discharged battery should be charged as soon as possible.

## Charging Batteries

The M3538A Lithium Ion Battery should be charged in either the HeartStart MRx or in a Philips-approved battery support system. The two methods of charging in the HeartStart MRx are as follows:

**Using AC power** - Insert the battery to be charged into Battery Compartment A. Insert the AC Power Module into Battery Compartment B and connect to an AC power source.

**Using DC power** - Insert a battery to be charged into Battery Compartment A. If a second battery is in need of charging, insert it in Battery Compartment B. Connect the DC Power Module to the HeartStart MRx and the DC power source.

Once AC or DC power is applied, the External Power Indicator turns green and batteries in the HeartStart MRx charge. Batteries are charged one at a time. With the HeartStart MRx turned off and at a temperature of 25°C (77°F), a fully discharged battery typically charges to 80% of its capacity in 2 hours, and to 100% of its capacity in 3 hours. Batteries charge at a slower rate with the device turned on.

Batteries should be charged at temperatures between 0°C (32°F) and 45°C(113°F).

## Charge Status


You can check the battery's state of charge by:

- periodically pushing the fuel gauge button on the battery to illuminate the fuel gauge. Each LED represents a charge of approximately 20% of capacity.
- turning the Therapy Knob to any mode of operation and observing the battery power indicators displayed in the General Status area (see “General Status” on page 16).

## Battery Calibration

Battery capacity diminishes with use and age. Battery calibration checks to see if the battery is nearing the end of its useful life and should be discarded. Battery calibration also ensures that the fuel gauge provides accurate estimates of the battery's state of charge, based on the total available capacity.

Calibrate a battery when the **Cal Recommended** message appears during an Operational Check, or every 6 months, whichever comes first. Battery calibration may be performed in the HeartStart MRx or in a Philips-approved battery support system. To calibrate a battery in the HeartStart MRx:

- 1 Connect the HeartStart MRx to AC or DC power.
- 2 Insert the battery to be calibrated into Battery Compartment A or B.
- 3 Turn the Therapy Knob to **Monitor**.
- 4 Press the Menu Select  button.
- 5 Using the Navigation buttons, select **Other** and press the Menu Select button.
- 6 Select **Battery Calibration** and press the Menu Select button.
- 7 Press the Menu Select button to acknowledge the message, **Leaving Normal Operational Mode**. The Calibration view is displayed. If external power is not detected, you are prompted to **Apply External Power**. If there is no battery in either battery compartment, you are prompted to **Insert Battery**. If there are batteries in both battery compartments, you must select which battery to calibrate.



- 8 Press the **[Start]** soft key to begin calibrating.

The calibration procedure charges the battery to full capacity, drains the battery in preparation for calibration, calibrates the battery, and then charges it again following calibration. Once you see the message, **Calibration Complete. The battery charges faster when the device is turned off**, you may turn the Therapy Knob to **Off** to allow the battery to charge more quickly.

Calibration takes approximately 11 hours to complete in the HeartStart MRx. Progress is shown on the display. It takes significantly less time to calibrate in a Philips-approved battery support system. Monitoring/therapy functions are not available during battery calibration in the MRx. If it is necessary to terminate calibration to resume clinical use, press the **[Cancel]** soft key.

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**WARNING** Battery calibration is terminated if external power or the battery being calibrated is removed before the calibration process is completed. If calibration is terminated, the battery will not be calibrated and its capacity may be very low.

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## Calibration Results

At the completion of battery calibration, a **Pass** or **Fail** is reported to indicate whether calibration completed successfully. In addition, an estimate of battery capacity is provided so that you can determine if the battery is fit for use. If the capacity is:

- $\geq 80\%$  continue to use the battery
- $< 80\%$  discard the battery

**NOTE** After successfully calibrating your batteries, perform an Operational Check. You may be prompted to recalibrate depending upon the condition of your battery.

## Storing Batteries

Batteries should be rotated regularly to ensure even usage. When storing batteries, make sure that the battery terminals do not come in contact with metallic objects.

If batteries are stored for an extended period of time, they should be stored in a cool place, with a partial charge of 20% (1 LED illuminated) to 40% (2 LED's illuminated) capacity. Storing batteries in a cool place slows the aging process. The ideal storage temperature is 15°C (60°F). Batteries should not be stored at temperatures outside the range of -20°C (-4°F) to 60°C (140°F).

- 
- CAUTION**
- Do not store batteries in the HeartStart MRx if it is out of service for an extended period of time.
  - Storing batteries at temperatures above 38°C (100°F) for extended periods of time significantly reduces a battery's life expectancy.
- 

Stored batteries should be charged every 2 months to 20% - 40% of their full capacity. They should be charged to full capacity prior to use.

## Discarding Batteries

Batteries should be discarded if there are visual signs of damage or if they fail calibration. Batteries should be discarded in an environmentally safe manner. Properly dispose of batteries according to local regulations.

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**WARNING** Do not disassemble, puncture, or incinerate batteries. Be careful not to short the battery terminals because this could result in a fire hazard.

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**CAUTION** Use caution when handling, using, and testing the batteries. Do not short circuit, crush, drop, mutilate, puncture, apply reverse polarity, expose to high temperatures, or disassemble. Misuse or abuse could cause physical injury.

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**NOTE** Wash skin with large amounts of water in the event of electrolyte leakage to prevent skin irritation and inflammation.

# Cleaning Instructions

Listed below are recommendations for cleaning the HeartStart MRx and its associated accessories.

- 
- CAUTION**
- The HeartStart MRx, along with its accessories and supplies, may not be autoclaved, steam sterilized, ultrasonically cleaned, or immersed unless otherwise indicated in the Instructions for Use that accompany the accessories and supplies.
  - Do not use abrasive cleaners or strong solvents such as acetone or acetone-based cleaners.
  - Do not mix disinfecting solutions (such as bleach and ammonia) as hazardous gases may result.
  - Do not clean electrical contacts or connectors with bleach.
  - Disinfect the device as determined by your institution's policy to avoid long-term damage to the device.
- 

## Monitor/Defibrillator

The following cleaning products may be used to clean the exterior surfaces of the monitor/defibrillator, as well as the batteries and data card:

- Isopropyl alcohol (70% solution in water).
- Mild soap and water.
- Sodium hypochlorite (chlorine bleach) (3% solution in water).
- Quaternary ammonium compounds (21% quaternary ammonium content) (such as Steris Coverage Plus NPD<sup>®</sup>) (.5 oz. per gallon water - one part Coverage Plus NPD<sup>®</sup> to 255 parts water).

Before cleaning, remove all adherent soil (tissue, fluids, etc.) and wipe thoroughly with a cloth dampened with water before applying the cleaning solution.

When cleaning, do not immerse. Wring any excess moisture from the cloth before cleaning. Be sure to avoid pouring fluids on the device, and do not allow fluids to penetrate the exterior surfaces of the device. To prevent scratching the display, the use of a soft cloth is recommended.

## Printer Printhead

If the printout has light or varying print density, clean the printhead to remove any buildup of paper residue.

To clean the printhead:

- 1 Push the printer door latch to open the door.
- 2 Remove the roll of paper.
- 3 Clean the printhead surface (above the brush) with a cotton swab dipped in isopropyl alcohol.
- 4 Replace the roll of paper.

## Paddles, Therapy Cable

External non-sterilizable paddles and the Therapy cables may be cleaned with a soft cloth moistened with:

- Mild soap and water.
- Gluteraldehyde solution (3.4% gluteraldehyde content such as CidexPlus®)
- Sodium hypochlorite (chlorine bleach) (3% solution in water).
- Quaternary ammonium compounds (21% quaternary ammonium content) (such as Steris Coverage Plus NPD) (.5 oz. per gallon water - one part Coverage Plus NPD to 255 parts water).
- Isopropyl alcohol (70% solution in water).

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**CAUTION** The paddles and Therapy cables may not be ultrasonically cleaned or immersed. Nor may they be autoclaved or ETO sterilized.

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**NOTE** For information about cleaning and sterilizing internal and external sterilizable paddles, see the *Sterilizable Defibrillator Paddles Instructions for Use*.

Philips' disposable sterile internal defibrillation paddles, multifunction electrode pads and monitoring electrodes are single use items and do not require cleaning.

## ECG Cable

For M3525A, M3526A, M3527A, M3528A, M3529A and 989803147691 ECG cables:

- Wipe clean with any of the following:
  - Isopropyl alcohol (70% solution in water).
  - Mild soap and water.
  - Gluteraldehyde solution (3.4% gluteraldehyde content such as CidexPlus).
  - Quaternary ammonium compounds (21% quaternary ammonium content such as Steris Coverage Plus NPD). Dilution: .5 oz. per gallon water - one part Coverage Plus NPD to 255 parts water.
  - Chlorine bleach (6% sodium hypochlorite), 3% solution in water. This solution may discolor the cable.

For any other approved ECG cable:

- Clean according to the manufacturer's instructions.

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**CAUTION** Do not ultrasonically clean, immerse, autoclave, or steam sterilize the ECG cable. Do not clean electrical contacts or connectors with chlorine bleach.

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## Carrying Case

The carrying case may be cleaned by hand with mild soap and water. Fabric stain removers may be used to remove stubborn stains. Air dry the carrying case. Do not wash or dry by machine.

## NBP Cuff

The cuff can be disinfected by immersion in a decontamination solution of 70-85% isopropyl alcohol, but remember to remove the rubber bag if you use this method. The cuff should not be dry cleaned.

The cuff can also be machine-washed or hand-washed as recommended by the manufacturer; the latter method will prolong the service life of the cuff. Before washing, remove the latex rubber bag and, for machine-washing, close the hook and loop fastening. Allow the cuff to dry thoroughly after washing, then reinsert the rubber bag.

## SpO<sub>2</sub> Sensor and Cable

To clean the SpO<sub>2</sub> sensor and cable, follow the instructions provided with the accessory.

## Invasive Pressures Transducer and Cable

To clean the invasive pressure cable, follow the instructions provided with the accessory.

## Temperature Probe and Cable

To clean the temperature probe and cable, follow the instructions provided with the accessory.

## Q-CPR Compression Sensor

The Compression Sensor may be cleaned with a soft cloth moistened with:

- mild soap and water.
- Glutaraldehyde solution (3.4% glutaraldehyde content, such as Johnson & Johnson Cidex Plus™).
- Sodium hypochlorite (chlorine bleach) (3% solution in water).
- Quaternary ammonium compounds (21% quaternary ammonium content, such as Steris Coverage Plus NPD™) (one part Coverage Plus NPD to 255 parts water).
- Isopropyl alcohol (70% solution in water).

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**CAUTION** • The Compression Sensor may not be immersed.

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## Disposing the HeartStart MRx

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

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**WARNING** Disposal of the device with the battery inserted presents a potential shock hazard.

To avoid contaminating or infecting personnel, the environment, or other equipment, make sure you disinfect and decontaminate the monitor/defibrillator and any appropriate device accessories appropriately prior to disposal.

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## Disposing Empty Calibration Gas Cylinders

To dispose of empty calibration gas cylinders:

- 1 Empty the cylinder completely by pushing the pin of the regulator valve or by pulling out the pin of the fill valve using a tire valve stem wrench or a pair of needle nose pliers.
- 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.

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

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# Supplies and Accessories

**WARNING** Use only supplies and accessories approved for use with your HeartStart MRx. Use of non-approved supplies and accessories could affect performance and results.

**WARNING** Use single-use supplies and accessories only once.

Approved supplies and accessories for your HeartStart MRx are listed in the following tables. To order: In the USA, call 1-800-225-0230 (pads, electrodes, cables, paper, etc.).

Outside the USA, contact your local Philips Medical Systems Sales Office, your authorized Philips Medical Systems Dealer or Distributor, or visit our website at: <http://shop.medical.philips.com> and follow the Supplies link.

**Table 61 Supplies and Accessories**

External Paddles	
M3542A	Standard External Paddles
M3543A	Water Resistant External Paddles
M4745A	Sterilizable External Paddles

Internal Paddles	
M1741A	7.5 cm Switchless
M1742A	6.0 cm Switchless
M1743A	4.5 cm Switchless
M1744A	2.8 cm Switchless
M4741A	7.5 cm Switched
M4742A	6.0 cm Switched
M4743A	4.5 cm Switched
M4744A	2.8 cm Switched
M4740A	Internal Paddles Adapter Cable

<b>Multifunction Electrode Pads</b>	
M3713A	Adult Plus
M3716A	Adult Radiolucent
M3717A	Pediatric Plus
M3718A	Adult Radiotransparent/Reduced Skin
M3719A	Pediatric Radiotransparent/Reduced Skin
M3501A	Defib Adult, AAMI
M3502A	Defib Adult, IEC
M3503A	Defib Pediatric, IEC
M3504A	Defib Pediatric, AAMI

<b>Pads Cables</b>	
M3507A	Defib Hands-free Pads Cable, barrel style - 2.2m (7 ft.)
M3508A	Hands-free Pads Cable, plug style - 2.2m (7 ft.)
05-10200	Pads Adapter (use with M3507A)

<b>ECG Monitoring Electrodes</b>	
M2202A	High-Tack Foam ECG Electrodes, 5 electrodes/pack (60 packs/case)

<b>12-Lead ECG Cable Set</b>	
M3525A	2.7 meter 10-lead ECG Trunk Cable, 12-pin Connector (for 3-Lead, 5-Lead and 12-Lead use)
989803147691	1.3 meter 10-lead ECG Trunk Cable, 12-pin Connector (for 3-Lead, 5-Lead and 12-Lead use)
M3526A	3-wire Lead Set with Snap (AAMI)
M3527A	Add 7-wire Lead Set for 12-Lead use (AAMI)
M3528A	3-wire Lead Set with Snap (IEC)
M3529A	Add 7-wire Lead Set for 12-Lead use (IEC)
M5530A	Combiner Plug for 3-wire Lead Set for use with M3526A/M3528A
M1949A	10-lead ECG Patient Trunk Cable, 12-pin ECG Input Connector (for 5-Lead and 12-Lead use)
M1968A	10-electrode Cable Set, Extremities, Grabber (use with M1976A) (AAMI)
M1976A	10-electrode Cable Set, Chest, Grabber (use with M1968A) (AAMI)
M1971A	10-electrode Cable Set, Extremities, Grabber (use with M1978A) (IEC)
M1978A	10-electrode Cable Set, Chest, Grabber (use with M1971A) (IEC)

<b>3-Lead ECG Cable Set</b>	
M1500A	3-lead ECG Trunk Cable (AAMI)
M1605A	3-lead ECG Lead Set with Snaps (AAMI)
M1510A	3-lead ECG Trunk Cable (IEC)
M1615A	3-lead ECG Lead Set with Snaps (IEC)



<b>5-Lead ECG Cable Set</b>	
M1520A	5-lead ECG Trunk Cable (AAMI)
M1625A	5-lead ECG Lead Set with Snaps (AAMI)
M1530A	5-lead ECG Trunk Cable (IEC)
M1635A	5-lead ECG Lead Set with Snaps (IEC)

<b>Sync Cables</b>	
M1783A	Sync Cable (8 ft.)
M5526A	Sync Cable (25 ft.)

<b>SpO<sub>2</sub> Sensors and Cables</b>	
M1191A	Reusable SpO <sub>2</sub> Sensor - Adult Finger
M1192A	Reusable SpO <sub>2</sub> Sensor - Pediatric/Small Adult Finger
M1194A	Reusable SpO <sub>2</sub> Sensor - Adult/Pediatric Ear Clip
M1195A	Reusable SpO <sub>2</sub> Sensor - Infant
M1941A	SpO <sub>2</sub> Extension Cable, 2 m
M1943A	Nellcor SpO <sub>2</sub> Sensor Adapter Cable, 1 m (use with M1903/4B)
M1131A	Disposable SpO <sub>2</sub> Sensor - Pediatric/Adult Finger
M1903B	Disposable SpO <sub>2</sub> Sensor - Pediatric Finger (Available outside the US only)
M1904B	Disposable SpO <sub>2</sub> Sensor - Adult Finger (Available outside the US only)

<b>NBP</b>	
	<b>Interconnect Tubing</b>
M1598B	Adult Pressure Interconnect Cable (1.5 m)
M1599B	Adult Pressure Interconnect Cable (3 m)
	<b>Reusable Blood Pressure Cuffs</b>
40400A	Reusable NBP Cuff Kit, 3 sizes (pediatric, adult, large adult)
40400B	Reusable NBP Cuff Kit, 5 sizes (infant, pediatric, adult, large adult, thigh)
40401A	Traditional Reusable NBP Cuff - Infant
40401B	Traditional Reusable NBP Cuff - Pediatric
40401C	Traditional Reusable NBP Cuff - Adult
40401D	Traditional Reusable NBP Cuff - Large Adult
40401E	Traditional Reusable NBP Cuff - Thigh
M4552A	Antimicrobial Reusable NBP Cuff - Infant
M4553A	Antimicrobial Reusable NBP Cuff - Pediatric
M4554A	Antimicrobial Reusable NBP Cuff - Small Adult
M4555A	Antimicrobial Reusable NBP Cuff - Adult
M4557A	Antimicrobial Reusable NBP Cuff - Large Adult
M4559A	Antimicrobial Reusable NBP Cuff - Thigh
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
	<b>Disposable Blood Pressure Cuffs</b>
M4572A	Soft Single-Patient Disposable Cuff - Infant
M4573A	Soft Single-Patient Disposable Cuff - Pediatric
M4574A	Soft Single-Patient Disposable Cuff - Small Adult
M4575A	Soft Single-Patient Disposable Cuff - Adult
M4576A	Soft Single-Patient Disposable Cuff - Adult X-Long
M4577A	Soft Single-Patient Disposable Cuff - Large Adult
M4578A	Soft Single-Patient Disposable Cuff - Large Adult X-Long
M4579A	Soft Single-Patient Disposable Cuff - Thigh

<b>EtCO<sub>2</sub></b>	
	<b>Intubated Circuits</b>
M1920A	FilterLine Set - Adult/Pediatric (25 sets/case)
M1921A	Filter H Set - Adult/Pediatric (25 sets/case)
M1923A	Filter H Set - Infant/Neonatal (yellow, 25 sets/case)
	<b>Non-Intubated Dual Purpose Circuits (CO<sub>2</sub> + O<sub>2</sub>)</b>
M2520A	Smart CapnoLine - Pediatric
M2522A	Smart CapnoLine - Adult
	<b>Non-Intubated Single Purpose Circuits (CO<sub>2</sub>)</b>
M2524A	Smart CapnoLine - Pediatric
M2526A	Smart CapnoLine - Adult

<b>Invasive Pressures</b>	
CPJ840J6	Reusable pressure transducer
CPJ84022	Sterile disposable pressure dome for use with CPJ840J6
CPJ84046	Transducer holder for CPJ840J6
M1567A	Single channel disposable blood pressure kit (available in Europe and Asia only)
M1568A	Dual Line blood pressure kit for measuring CVP, ABP and other pressure measurements. (available in Europe and Asia only)
M1634A	Reusable adapter cable (available in Europe and Asia only)

<b>Temperature</b>	
	<b>Disposable Temperature Probes</b>
21090A	Esophageal/rectal
21091A	Skin surface
21093A	Esophageal stethoscope
21094A	Esophageal stethoscope
21095A	Esophageal stethoscope
21096A	Foley catheter
21097A	Foley catheter
M1837A	Esophageal/rectal
M2255A	Foley catheter
	<b>Reusable Temperature Probes</b>
21075A	Esophageal/rectal - adult
21076A	Esophageal/rectal - pediatric
21078A	Skin surface
	<b>Reusable Temperature Probe Extension Cables</b>
21082A	3.0m 2-pin plug extension cable for mini phone plug
21082B	1.5m 2-pin plug extension cable for mini phone plug

<b>Power</b>	
M3538A	Lithium Ion Battery
M3539A	AC Power Module
M5529A	DC Power Module
M5528A	DC Power Module Mounting Bracket
989803135301	2-Bay Battery Support System for Lithium Ion Batteries
989803135331	4-Bay Battery Support System for Lithium Ion Batteries
989803135341	4-Bay Battery Support System for Sealed Lead Acid and Lithium Ion Batteries

<b>Q-CPR</b>	
M4761A	Compression Sensor
M4762A	Compression Sensor Adhesive Pads (Package of 10)
M4763A	Pads/CPR Cable

<b>Paper</b>	
40457C	50 mm Chemical Thermal Paper, Gray Grid (10 rolls)
40457D	50 mm Chemical Thermal Paper, Gray Grid (80 rolls)
989803138171	75 mm Chemical Thermal Paper, Gray Grid (10 rolls)
989803138181	75 mm Chemical Thermal Paper, Gray Grid (80 rolls)

<b>Color Handle</b>	
M5521A	Green
M5522A	Blue
M5523A	Yellow
M5524A	Rose
M5525A	Gray

<b>Miscellaneous</b>	
M1781A	Test Load for use with M3507A Pad Cable
M3725A	Test Load for use with M3508A Pad Cable
M3541A	Carrying Case
989803146981	Data Card and Tray
M3544A	Data Card Tray
M4737A	Display Cover
M3549A	Wide bedrail hook

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# Troubleshooting

If the HeartStart MRx detects an error or potential problem during use, it displays an INOP statement or a message window with text to guide you. INOP statements and messages are often accompanied by a voice prompt or an audible beeping tone. This chapter describes the INOP statements and messages that you may see, along with other symptoms, and provides suggestions for what to do. In addition, this chapter provides an explanation of audible tones and information on contacting your service representative.

If you are unable to resolve a problem using the suggestions in this chapter:

- Run an Operational Check to determine if there is a malfunction requiring service.
- If a malfunction is identified, call for service.
- Take the HeartStart MRx out of use if there is a malfunction affecting ECG monitoring, defibrillation, or pacing. For malfunctions related to SpO<sub>2</sub>, NBP, Invasive Pressures, Temperature, CO<sub>2</sub> monitoring, or 12-Lead functionality, take the device out of service if the function is essential to patient care in your organization.

Results of Automated Tests associated with critical functionality of the device are reported through the Ready For Use indicator and the Automated Test Summary report. For information on responding to these results, see “Ready For Use Indicator” on page 218. To respond to errors reported through Operational Check see “Operational Check Test Results” on page 231.

For further technical and repair information, refer to the HeartStart MRx *Service Manual*.

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**WARNING** Product servicing and repair should only be performed by qualified service personnel.

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## Symptoms

The following tables list symptoms, INOP statements, and messages that you may encounter, along with possible causes of the problem, and potential solutions. Symptoms are characterized by functionality.

**Table 62 General Problems**

Symptom	Possible Cause	Possible Solution
The HeartStart MRx does not turn on.	There is no power.	<ul style="list-style-type: none"> <li>Insert a fully charged battery.</li> <li>Connect to AC/DC power.</li> </ul>
Audio is too low or absent.	The <b>QRS</b> , <b>Voice</b> , or <b>Alarm</b> volume is configured to a <b>Very Soft</b> or <b>Off</b> setting.	Use the <b>Volume</b> menu to adjust the volume of the QRS beeper, voice prompts, and/or alarms.
Low battery life (appears to deplete quickly).	The battery may be nearing its end of life.	Replace the battery.
Battery charge indicators inaccurate.	The battery may need calibration.	Calibrate the battery.
<b>All Settings Have Been Reset To Default Values</b> message.	A power failure or critical software error has occurred.	Reset alarms, waveforms, volumes, and other settings previously defined for the current patient.
<b>All Settings Have Been Set To Factory Default Values</b> message, accompanied by a <b>Power Interrupted</b> or <b>Device Restarted</b> message.	Corrupt or incomplete configuration file.	Reload device configuration file.
<b>Batteries Low</b> message.	The batteries may not have enough remaining charge to provide 10 minutes of monitoring time or six 200J shocks.	<ul style="list-style-type: none"> <li>Insert a fully charged battery.</li> <li>Connect to AC/DC power.</li> </ul>
<b>Battery A Low - Switching to Battery B</b> (or vice-versa) message.	The specified battery needs charging.	Charge the low battery.
<b>Device Error. Service Required.</b> message	Failure detected during start-up.	Take the device out of use and call for service.
<b>External Power Interrupted</b> message.	AC/DC power was removed; now operating from battery power.	Connect to AC/DC power, if appropriate.
<b>Fan Failure</b> message.	The internal fan should be running but it is not.	Call for service.
<b>Internal Memory Failure</b> message.	The internal memory card has been reformatted after failing an automated test.	Although all previous data stored on the card has been erased, it is now ready once again to record data.
INOP message appears every time the device is turned on.	<p>Patient data cannot be stored in internal memory because the internal memory card is not recognized.</p> <p>An attempt to print an Event Summary or trending report was requested during power up.</p>	<p>Call for service.</p> <p>Data Card was not available. Cycle the power. Wait at least 16 seconds after power up before attempting to print an Event Summary or trending report.</p>

Table 62 General Problems (Continued)

Symptom	Possible Cause	Possible Solution
<b>Event Storage Full</b> message.	Event Summary data for the current patient case exceeds the storage capacity of internal memory or you've reached the 12-hour limit.	<ul style="list-style-type: none"> <li>• Copy or print Event Summary to retain data and then begin a new patient case.</li> <li>• Print the Event Summary Report. Begin a new patient case.</li> </ul>
<b>Power Supply Failure</b> INOP.	There is a problem with the internal power supply.	Remove the device from use and call for service.
<b>Replace Clock Battery</b> message.	The battery on the internal clock needs to be replaced.	Call for service.
<b>Shock Equip Malfunction</b> INOP.	A shock can not be delivered due to a hardware failure.	Remove the device from use and call for service.
<b>Shutting Down in 1 Minute</b> message.	Very low battery and the device is not connected to AC/DC power.	Insert a charged battery and/or connect to AC/DC power.
<b>Shutting Down Now</b> message.	Battery charge is depleted and the device is not connected to AC/DC power.	Insert a charged battery and/or connect to AC/DC power. Settings for the current patient may need to be reset.

Table 63 ECG Monitoring Problems

Symptom	Possible Cause	Possible Solution
QRS beeper inaudible or beeps do not occur with each QRS complex.	<p>The QRS volume is configured to <b>Off</b> or the setting is too low.</p> <p>The QRS volume was turned <b>Off</b> or set too low through the Volume menu.</p> <p>The amplitude of the QRS complex is too small to detect.</p>	<p>Configure the QRS beeper volume.</p> <p>Adjust the volume through the Volume menu.</p> <p>Select a different lead.</p>
Poor ECG signal quality (noisy trace, wandering baseline, etc.) from signal acquired through monitoring electrodes.	<p>The monitoring electrodes are not making proper contact with the patient.</p> <p>The monitoring electrodes are outdated or dried-out.</p> <p>Radio frequency interference (RFI) is causing artifact.</p> <p>The ECG cable may be faulty.</p>	<p>Check that the monitoring electrodes are properly applied. If necessary, prepare the patient's skin and apply new electrodes.</p> <p>Check the date code on the electrodes. Do not open the electrode package until immediately prior to use.</p> <p>Relocate or turn off equipment that may be causing RFI. Try repositioning cables/leads.</p> <p>Run the Operational Check with the ECG cable. If the test fails, run it without the ECG cable. If the test passes, replace the cable. If not, remove the device from use and call for service.</p>
Poor ECG signal quality (noisy trace, wandering baseline, etc.) from signal acquired through paddles/pads.	<p>The paddles/pads are not making proper contact with the patient.</p> <p>The pads are outdated or dried-out.</p> <p>Radio frequency interference (RFI) is causing artifact.</p> <p>The paddles/pads cable may be faulty.</p>	<p>Ensure proper skin preparation and correction application. If necessary, apply new pads.</p> <p>Check the date code on the pads. Do not open the pads package until immediately prior to use.</p> <p>Relocate or turn off equipment that may be causing RFI. Try repositioning the pads cable.</p> <p>Run the Operational Check with the pads cable. If the test fails, run it without the pads cable. If the test passes, replace the cable. If not, remove the device from use and call for service.</p>
<b>ECG Unplugged</b> INOP.	No ECG cable is connected and the configured/selected ECG in Wave Sector 1 is from leads	Check that the ECG cable is firmly connected. Connect an ECG cable or a pads therapy cable.
<b>Leads Off</b> INOP.	<p>Electrode(s) for the configured/selected ECG in Wave Sector 1 may be off or insecurely attached.</p> <p>Electrode(s) are not making proper contact with the patient.</p>	<p>Apply electrodes/pads to the patient.</p> <p>Check that monitoring electrodes are properly applied. If necessary, prepare the patient's skin and apply new electrodes.</p>
Solid flat line - no waveform, no <b>Leads Off</b> INOP.	Short in patient cable or leads.	Run the Operational Check with the ECG cable. If the test fails, run it without the ECG cable. If the test passes, replace the cable. If not, remove the device from use and call for service.



Table 63 ECG Monitoring Problems (Continued)

Symptom	Possible Cause	Possible Solution
<b>Pads/Paddles Off</b> INOP	Pads/Paddles for Wave Sector 1 are off or insecurely attached.	<ul style="list-style-type: none"> <li>Check that pads/paddles are properly applied. If necessary, replace the pads.</li> <li>Change the ECG in Wave Sector 1 to a lead derived from monitoring electrodes.</li> </ul>
There is a dashed line (---) on the display instead of an ECG.	ECG data is not being acquired.	<ul style="list-style-type: none"> <li>Check the pads, paddles or ECG cable is connected.</li> <li>Check the pads, paddles, or monitoring electrodes are properly applied.</li> <li>Check that the desired lead is selected.</li> </ul>
<b>"Lead-wire" Off</b> message displayed in wave sector.	The specified monitoring electrode is off or not making proper contact with the patient.	Check that monitoring electrodes are properly applied. If necessary, prepare the patient's skin and apply new electrodes.
<b>Check Limb Leads</b> message displayed in wave sector.	2 or more limb lead electrodes are off or not making proper contact with the patient.	Check that the limb lead electrodes are properly applied.
<b>Pads Off</b> message displayed in a wave sector.	Pads are not making proper contact with the patient.	Make sure the pads therapy cable is connected and pads are properly applied. If necessary, prepare the patient's skin and apply new pads.
<b>Cannot Analyze ECG</b> INOP.	The arrhythmia algorithm cannot reliably analyze the ECG data.	Check ECG signal quality. If necessary, improve lead position or reduce patient motion.
<b>Pads ECG Cable Failure</b> INOP.	A short was detected between a lead wire and ground.	Replace the pads cable and perform an Operational Check.
<b>ECG Cable Failure</b> INOP.	A short has been detected between a lead wire and ground.	Replace the ECG cable.
<b>Pads ECG Equip Malfunction</b> INOP.	A device hardware failure was detected.	Perform an Operational Check. If the Pads/Paddles ECG Test fails with Therapy cable, disconnect the Therapy cable from the device when prompted in order for the Pads/Paddles ECG Test to run without the cabled connected. If the Pads/Paddles ECG test passes without the cable connected, replace the Therapy cable.
<b>ECG Equip Malfunction</b> INOP.	A device hardware failure was detected.	Disconnect the ECG cable and perform an Operational Check. If the Leads ECG Test fails, remove the device from use and call for service. If the Leads ECG Test passes, replace the ECG cable and perform an Operational Check.

Table 63 ECG Monitoring Problems (Continued)

Symptom	Possible Cause	Possible Solution
Lead Select button does not respond.	The 12-lead function is active. Device is in AED Mode.	Exit the 12-lead function. None.
Lead Select button does not display a pads choice.	The pads therapy cable is not connected. Demand mode pacing is active.	Connect the pads therapy cable. Exit pacing or choose fixed mode pacing.
One or more controls do not respond (e.g., select lead or soft keys).	Faulty control or connection.	Remove the device from use and call for service.
<b>Therapy Cable Failure</b> INOP	Performing an Operational Check without a therapy cable attached.	Connect a therapy cable and rerun Operational Check.

Table 64 NBP Monitoring Problems

Symptom	Possible Cause	Possible Solution
<b>NBP Cuff Not Deflated</b> INOP. The NBP numeric value is replaced with a -?-.	The NBP cuff pressure has been greater than 5mmHg (0.67kPa) for more than 3 minutes.	<ul style="list-style-type: none"> <li>Remove cuff from patient.</li> <li>Release pressure in the cuff (disconnect cuff from tubing).</li> <li>Replace the cuff. If the problem persists, call for service.</li> </ul>
<b>NBP Cuff Overpressure</b> INOP. The NBP numeric value is replaced with a -?-.	The NBP cuff pressure has exceeded the overpressure safety limit of 300 mmHg.	No action is required, the cuff should deflate automatically. If not, remove cuff from patient and deflate.
<b>NBP Interrupted</b> INOP. The NBP numeric value is replaced with a -?/-?-(?-).	The measurement needed longer than the maximum time provided for inflation, deflation, or the total measurement.	<ul style="list-style-type: none"> <li>Check that the cuff size is appropriate.</li> <li>Check cuff placement.</li> </ul>
<b>NBP Measurement Failed</b> INOP. The NBP numeric value is replaced with a -?/-?-(?-).	A measurement value could not be obtained.	Check cuff size and placement.
<b>NBP Calibration Overdue</b> INOP.	NBP module needs calibration. Calibration should be performed once a year or every 10,000 cycles, whichever comes first.	Call for service of the NBP module. Do not use the NBP monitoring capabilities until the calibration has been performed. If NBP monitoring is essential to patient care, take the device out of use.
<b>NBP Equip Malfunction</b> INOP.	NBP hardware failure.	Call for service of the NBP module. Do not use the NBP monitoring capabilities. If NBP monitoring is essential to patient care, take the device out of use.

Table 64 NBP Monitoring Problems

Symptom	Possible Cause	Possible Solution
<b>NBP Service Required</b> INOP.	The NBP module has reached its end of life, defined as 50,000 cycles.	Call for service of the NBP module. Do not use the NBP monitoring capabilities. If NBP monitoring is essential to patient care, take the device out of use.
Measurement cycle doesn't automatically start.	NBP is not configured for automatic measurements.  Automatic measurements are not scheduled for the current patient.  The [ <b>Start NBP</b> ] soft key has not been pressed.	Check/modify the configuration as needed.  Use the <b>Measurements/Alarms</b> menu to define an automatic schedule of measurements for the current patient.  Press the [ <b>Start NBP</b> ] soft key.
The pump operates, but the cuff does not inflate or fails to inflate fully.	Defective cuff.  Poor connection between the cuff and the HeartStart MRx.	Replace the cuff.  Check connections and replace tubing, if needed.
NBP measurements appear high/low.	The cuff size is too small/large for the patient.	Use the correct cuff size.

Table 65 SpO<sub>2</sub> Monitoring Problems

Symptom	Possible Cause	Possible Solution
The SpO <sub>2</sub> waveform is not displayed.	The sensor is not properly connected or the sensor cable is damaged.  The SpO <sub>2</sub> waveform is not configured to be displayed and there is not an unused wave sector.	<ul style="list-style-type: none"> <li>Check the sensor connection and cable.</li> <li>Try another sensor.</li> </ul> Use the <b>Displayed Waves</b> menu to select a wave sector for display of the SpO <sub>2</sub> waveform.
SpO <sub>2</sub> <b>Non Pulsatile</b> INOP.	The patient's pulse is absent or too weak to be detected.  The sensor has come off.	<ul style="list-style-type: none"> <li>Check perfusion at the measurement site.</li> <li>Check that the sensor is applied properly.</li> <li>Make sure the sensor site has a pulse.</li> <li>Relocate the sensor to another site with improved circulation.</li> <li>If the message occurs due to NBP measurement on the same limb, wait until the NBP measurement is finished.</li> <li>Try another sensor.</li> </ul>
SpO <sub>2</sub> <b>Erratic</b> INOP.  The SpO <sub>2</sub> numeric value is replaced with a -?-.	SpO <sub>2</sub> measurement readings are erratic.	<ul style="list-style-type: none"> <li>Check that the sensor is applied properly.</li> <li>Make sure the sensor site has a pulse.</li> <li>Relocate the sensor to another site with improved circulation.</li> <li>Try another sensor.</li> </ul>
SpO <sub>2</sub> <b>Noisy Signal</b> INOP.	Excessive patient movement or electrical interference.	<ul style="list-style-type: none"> <li>Minimize patient movement.</li> <li>Make sure the sensor cable is not positioned too close to power cables.</li> </ul>
SpO <sub>2</sub> <b>Interference</b> INOP.  The SpO <sub>2</sub> numeric value is replaced with a -?-.	Ambient light is too high.  There is too much interference.  The sensor is damaged.	Cover the sensor with an opaque material to minimize ambient light.  Make sure the sensor cable is not positioned too close to power cables.  Make sure that the sensor cable is not damaged.
SpO <sub>2</sub> <b>Unplugged</b> INOP.	The SpO <sub>2</sub> sensor is not connected.	Check the SpO <sub>2</sub> connection.
SpO <sub>2</sub> <b>Unplugged. Turn off SpO<sub>2</sub>? message</b> appears when the device is turned on and the SpO <sub>2</sub> sensor is not connected.	The SpO <sub>2</sub> sensor is not connected.  The software was not upgraded after an SpO <sub>2</sub> repair or upgrade was performed.	<ul style="list-style-type: none"> <li>Check that the sensor connection is secure. Try another sensor.</li> <li>Call for service.</li> </ul>

Table 65 SpO<sub>2</sub> Monitoring Problems (Continued)

Symptom	Possible Cause	Possible Solution
<b>SpO<sub>2</sub> Sensor Malfunction</b> INOP. The SpO <sub>2</sub> numeric value is replaced with a -?-.	The SpO <sub>2</sub> sensor or cable is faulty.	<ul style="list-style-type: none"> <li>Try another sensor.</li> <li>If the problem persists, call for service of the SpO<sub>2</sub> module. If SpO<sub>2</sub> monitoring is essential to patient care, take the device out of use.</li> </ul>
<b>SpO<sub>2</sub> Equip Malfunction</b> message.	Faulty SpO <sub>2</sub> hardware.	<ul style="list-style-type: none"> <li>Call for service of the SpO<sub>2</sub> module. If SpO<sub>2</sub> monitoring is essential to patient care, take the device out of use.</li> </ul>
<b>SpO<sub>2</sub> Extended Update</b> INOP. The SpO <sub>2</sub> numeric value is replaced with a -?-.	An NBP measurement or an excessively noisy signal is delaying display/update of the SpO <sub>2</sub> measurement for more than 60 seconds.	<ul style="list-style-type: none"> <li>Wait until the NBP measurement is complete.</li> <li>Try another sensor site.</li> <li>Move sensor to a different limb from the NBP cuff.</li> </ul>
<b>SpO<sub>2</sub> Low Perfusion</b> INOP. The SpO <sub>2</sub> numeric value is replaced with a -?-.	The SpO <sub>2</sub> signal is too low to give an accurate reading.	<ul style="list-style-type: none"> <li>Check the sensor is applied properly.</li> <li>Try another sensor type.</li> </ul>

Table 66 12-Lead Transmission Problems (Bluetooth)

Symptom	Possible Cause	Possible Solution
<b>Bluetooth Malfunction</b> INOP.	<ul style="list-style-type: none"> <li>The MRx does not have a Bluetooth card.</li> <li>The Bluetooth card is incompatible.</li> <li>The Bluetooth card is corrupt.</li> </ul>	<ul style="list-style-type: none"> <li>Call for service.</li> <li>Call for service.</li> <li>Call for service.</li> </ul>
<b>No Bluetooth Devices Detected</b> message.	<ul style="list-style-type: none"> <li>The MRx could not discover the Bluetooth device.</li> <li>The Bluetooth device is not turned on.</li> <li>The Bluetooth device is not authorized to pair with the MRx.</li> <li>The Bluetooth device is not within range.</li> <li>The Bluetooth card is corrupt.</li> </ul>	<ul style="list-style-type: none"> <li>Try searching again for Bluetooth devices.</li> <li>Make sure the Bluetooth device is turned on.</li> <li>See the Bluetooth device's documentation to set authorization.</li> <li>Move the Bluetooth device closer to the MRx, within the transmitting range. (See the <i>12-Lead Transmission Implementation Guide</i> for information on transmission ranges.)</li> <li>Call for service.</li> </ul>
<b>No Bluetooth Profiles Configured</b> message.	<ul style="list-style-type: none"> <li>There are no profiles configured for the Bluetooth device.</li> </ul>	<ul style="list-style-type: none"> <li>Create a profile for the Bluetooth device. See the <i>12-Lead Transmission Implementation Guide</i> for more information.</li> </ul>
<b>Transmission Settings Have Not Been Configured</b> message.	<ul style="list-style-type: none"> <li>The Hub information settings are not correct.</li> </ul>	<ul style="list-style-type: none"> <li>Modify the Hub Configuration settings on the MRx as needed.</li> </ul>
<b>Bluetooth Connection Lost</b> message.	<ul style="list-style-type: none"> <li>The Bluetooth device is not within range.</li> </ul>	<ul style="list-style-type: none"> <li>Move the Bluetooth device closer to the MRx, within the transmitting range. (See the <i>12-Lead Transmission Implementation Guide</i> for information on transmission ranges.)</li> </ul>
<b>Bluetooth device pairing failed</b> message.	<ul style="list-style-type: none"> <li>The wrong pass code was entered on the Bluetooth device</li> <li>The pairing process timed out.</li> <li>The Bluetooth card is corrupt.</li> </ul>	<ul style="list-style-type: none"> <li>Check the pass code. Select the device from the MRx Add Devices list and pair again.</li> <li>Try pairing again.</li> <li>Call for service.</li> </ul>
<b>No Bluetooth Devices Configured</b> message.	<ul style="list-style-type: none"> <li>The Bluetooth device has not been paired with the MRx.</li> </ul>	<ul style="list-style-type: none"> <li>Pair the Bluetooth device with the MRx.</li> </ul>

Table 66 12-Lead Transmission Problems (Bluetooth) (Continued)

Symptom	Possible Cause	Possible Solution
<b>No transmission devices detected</b> message.	<ul style="list-style-type: none"> <li>The Bluetooth device is not turned on.</li> <li>The Bluetooth device is not within range.</li> <li>The Bluetooth pairing information has been lost.</li> <li>The Bluetooth card is corrupt.</li> </ul>	<ul style="list-style-type: none"> <li>Make sure the Bluetooth device is turned on.</li> <li>Move the Bluetooth device closer to the MRx, within the transmitting range. See the <i>12-Lead Transmission Implementation Guide</i> for more information.</li> <li>Pair the Bluetooth device with the MRx.</li> <li>Replace the Bluetooth card.</li> </ul>
<b>Transmission Failed. No Dial Tone.</b> message.	<ul style="list-style-type: none"> <li>Cell phone service is unavailable.</li> <li>The Bluetooth modem connection is not secure.</li> <li>The connection you are using does not provide dial tones.</li> </ul>	<ul style="list-style-type: none"> <li>Check that the cellular signal strength is sufficient.</li> <li>Check that the connection between the Bluetooth modem and the analog line is secure.</li> <li>Set the “Wait for Dial Tone” configuration parameter to <b>No</b>. See the <i>12-Lead Transmission Implementation Guide</i> for more information.</li> </ul>
<b>Transmission Failed. Error configuring transmission device.</b> message.	<ul style="list-style-type: none"> <li>The wrong Bluetooth Profile was selected.</li> <li>The Configuration String under the Bluetooth Profile settings is not correct.</li> </ul>	<ul style="list-style-type: none"> <li>Check the profile to ensure it is the correct one for that Bluetooth device.</li> <li>Work with your cell phone provider to ensure that the Configuration String is correct.</li> </ul>
<b>Transmission Failed. Connection Interrupted.</b> message.	<ul style="list-style-type: none"> <li>The network is down.</li> <li>The Bluetooth device is not within range.</li> </ul>	<ul style="list-style-type: none"> <li>Check that the cellular signal strength is sufficient.</li> <li>Move the Bluetooth device closer to the MRx, within the transmitting range. See the <i>12-Lead Transmission Implementation Guide</i> for more information.</li> </ul>
<b>Transmission Failed. Cannot reach server.</b> message.	<ul style="list-style-type: none"> <li>No server or the connection has been lost.</li> </ul>	<ul style="list-style-type: none"> <li>Resend the 12-Lead Report.</li> </ul>
<b>Transmission Failed. Server Unknown.</b> message.	<ul style="list-style-type: none"> <li>The DNS has timed out or there has been a failure in the DNS.</li> </ul>	<ul style="list-style-type: none"> <li>Work with your ISP to ensure the Bluetooth Profile and Hub settings are correct.</li> </ul>

Table 66 12-Lead Transmission Problems (Bluetooth) (Continued)

Symptom	Possible Cause	Possible Solution
<b>Transmission Failed. Settings Configured Incorrectly.</b> message.	<ul style="list-style-type: none"> <li>There is a problem with the Server URL, Proxy user name, Proxy password</li> </ul>	<ul style="list-style-type: none"> <li>Work with your ISP to ensure the Bluetooth Profile and Hub settings are correct.</li> </ul>
<b>Transmission Failed. Connection Failed.</b> message.	<ul style="list-style-type: none"> <li>The wrong Bluetooth Profile was selected.</li> <li>The Dial String under the Phone Profile settings is incorrect.</li> <li>Data transfer service is unavailable on the phone.</li> <li>Wrong number.</li> </ul>	<ul style="list-style-type: none"> <li>Check the profile to ensure it is the correct one for that Bluetooth device.</li> <li>Work with your cell phone provider to ensure that the Dial string is correct.</li> <li>Work with your cell phone provider to ensure that your cell phone plan has data transfer capability.</li> <li>Check the number and re-send.</li> </ul>
<b>Invalid Password</b> message.	<ul style="list-style-type: none"> <li>The wrong Bluetooth Profile was selected.</li> <li>The PPP User Name or PPP Password under the Profile Phone settings is incorrect.</li> <li>The server User Name or Password is incorrect.</li> </ul>	<ul style="list-style-type: none"> <li>Check the profile to ensure it is the correct one for that Bluetooth device.</li> <li>Modify the Bluetooth Profile setting as needed.</li> <li>Modify the Hub settings as needed.</li> </ul>
<b>Transmission Failed</b> message.	<ul style="list-style-type: none"> <li>The network is down.</li> <li>The server connection has timed out.</li> <li>TCP/IP Failure</li> <li>The web server has rejected the data.</li> </ul>	<ul style="list-style-type: none"> <li>Check with your ISP to see if your service is down.</li> <li>Re-send the 12-lead report.</li> <li>Re-send the 12-lead report. If still unsuccessful, check the MRx configuration settings.</li> <li>Check the MRx and the 12-Lead Transfer Station to ensure that the correct product versions are installed.</li> </ul>



**Table 67 12-Lead Transmission Problems (RS 232)**

First, attempt to solve the problem by disconnecting the serial cable from the cell phone, reconnecting it, and resending the 12-Lead Report.

Symptom	Possible Cause	Possible Solution
<b>Transmission Settings Have Not Been Configured</b> message.	Hub information has not been entered or is entered incorrectly in Configuration.	Modify the Hub configuration settings as needed.
<b>No Transmission Devices Detected</b> message.	The cell phone is not an approved model for 12-Lead Transmission.  The cell phone's RS 232 port has not been configured.  The cell phone is not connected properly.  The serial cable is defective or incompatible.	Use an approved cell phone model. See the requirements listed in the <i>12-Lead Transmission Implementation Guide</i> .  Check the cell phone configuration settings.  Check that the cell phone is turned on and the connection is secure.  Disconnect and reconnect the serial cable.  Work with your cell phone provider to obtain a serial cable that connects to your phone with a 9-pin D serial cable connection.
<b>No Dial Tone</b> message.	There is no dial tone.  Cell phone service is unavailable.	Check that the connections are secure.  Check that the cellular signal strength is sufficient.
<b>Transmission Failed</b> message, accompanied by an <b>Error Configuring Transmission Device</b> message	The phone configuration settings are invalid/incorrect.  Wrong number.	Modify the Serial Phone Profile configuration settings as needed. For more information refer to the <i>12-Lead Transmission Implementation Guide</i> .  Check the number and re-send.
<b>Invalid Password</b> message.	The Internet Service Provider (ISP) or Hub user name or password is incorrect.	Modify the Serial Phone Profile or Hub configuration settings as needed. For more information refer to the <i>12-Lead Transmission Implementation Guide</i> .
<b>Transmission Failed</b> message, accompanied by a <b>Connection Failed</b> message.	The connection with the ISP cannot be made.	Modify the Serial Phone Profile configuration settings as needed. For more information refer to the <i>12-Lead Transmission Implementation Guide</i> .
<b>Transmission Failed</b> message, accompanied by a <b>Cannot Reach Server</b> message.	The network server is unavailable.	Contact the network administrator.

**Table 67 12-Lead Transmission Problems (RS 232) (Continued)**

First, attempt to solve the problem by disconnecting the serial cable from the cell phone, reconnecting it, and resending the 12-Lead Report.

Symptom	Possible Cause	Possible Solution
<b>Transmission Failed</b> message, accompanied by a <b>Server Unknown</b> message	Server Name or address is not recognized.	Modify the Server configuration settings as needed. For more information refer to the <i>12-Lead Transmission Implementation Guide</i> .
<b>Transmission Failed</b> message, accompanied by a <b>Connection Interrupted</b> message.	The connection with the network server has terminated.	Choose the destination site again and re-connect.
<b>Transmission Failed</b> message, accompanied by a <b>Settings Configured Incorrectly</b> message	The URL or Proxy configuration settings are incorrect.	Modify the Serial Phone Profile, Hub or Site configuration settings as needed. For more information refer to the <i>12-Lead Transmission Implementation Guide</i> .
<b>Transmission Failed</b> message.	The 12-Lead Report did not transmit correctly.	Choose the destination site again and re-connect. Check the cell phone connection to the HeartStart MRx.
	The network is down.	Check with your internet provider to see if your service is unavailable.

**Table 68 CO<sub>2</sub> Monitoring Problems**

Symptom	Possible Cause	Possible Solution
The CO <sub>2</sub> waveform does not appear on the display.	The FilterLine is not properly connected.  The CO <sub>2</sub> waveform is not configured to be displayed and there is not an unused wave sector.	<ul style="list-style-type: none"> <li>• Check the FilterLine connection.</li> <li>• Check tubing for knots, kinks or pinches.</li> </ul> Use the <b>Displayed Waves</b> menu to select a wave sector for display of the CO <sub>2</sub> waveform.
CO <sub>2</sub> <b>Unplugged</b> INOP.	The FilterLine is disconnected.	<ul style="list-style-type: none"> <li>• Check the FilterLine connection and tubing.</li> <li>• Check the tubing for knots, kinks, or pinches.</li> </ul>
CO <sub>2</sub> <b>Purging</b> INOP.	A blockage in the FilterLine or airway adapter has been detected. If it is not successful, a CO <sub>2</sub> Occlusion condition will occur.	The HeartStart MRx automatically attempts to purge the blockage.
CO <sub>2</sub> <b>Occlusion</b> INOP.	Attempts to purge the FilterLine and exhaust tube were unsuccessful. A sample cannot be taken because of the blockage.	Make sure the FilterLine and exhaust tubing (if connected) are not kinked and are free of blockages. Then disconnect and reconnect the FilterLine to retry. If necessary, replace the FilterLine and/or exhaust tubing.
CO <sub>2</sub> <b>Overrange</b> INOP.	The CO <sub>2</sub> value is higher than the measurement range.	If you suspect a false high value, do not use the CO <sub>2</sub> monitoring capabilities and call for service of the CO <sub>2</sub> module. If CO <sub>2</sub> monitoring is essential to patient care, take the device out of use.
CO <sub>2</sub> <b>Auto Zero</b> INOP.	The automatic zero process is running. It takes from 10 to 30 seconds and CO <sub>2</sub> values are invalid at this time.	No action required. The module automatically resets itself.

Table 68 CO<sub>2</sub> Monitoring Problems (Continued)

Symptom	Possible Cause	Possible Solution
CO <sub>2</sub> <b>Calibration Overdue</b> INOP.	The CO <sub>2</sub> module should be calibrated once a year or after 4,000 operating hours.	Do not use the CO <sub>2</sub> monitoring capabilities and call for service to calibrate the CO <sub>2</sub> module. If CO <sub>2</sub> monitoring is essential to patient care, take the device out of use.
CO <sub>2</sub> <b>Check Exhaust</b> INOP.	When CO <sub>2</sub> is turned on, the exhaust tube is blocked to the extent that a measurement sample cannot be taken.	Make sure the exhaust tubing is not kinked and is free of blockages. If necessary, replace the tubing.
CO <sub>2</sub> <b>Equip Malfunction</b> INOP	CO <sub>2</sub> hardware failure.	Do not use the CO <sub>2</sub> monitoring capabilities and call for service of the CO <sub>2</sub> module. If CO <sub>2</sub> monitoring is essential to patient care, take the device out of use.
CO <sub>2</sub> <b>Service Required</b> INOP.	The CO <sub>2</sub> module has reached its end of life, defined as 15,000 operating hours.	Do not use the CO <sub>2</sub> monitoring capabilities and call for service of the CO <sub>2</sub> module. If CO <sub>2</sub> monitoring is essential to patient care, take the device out of use.

Table 69 Defibrillation and Pacing Problems

Symptom	Possible Cause	Possible Solution
<b>Analyzing Stopped</b> , or <b>Cannot Analyze ECG</b> message in AED Mode.	Excessive patient movement.  Radio or electrical sources are interfering with ECG analysis.	Minimize patient movement. If the patient is being transported, stop if necessary.  Remove possible sources of interference from the area.
<b>Charge Button Failure</b> INOP	During an Operational Check, when the Charge button was pressed, there was no response.	Remove the device from use and call for service.
<b>Defib Disarmed</b> message.	The Shock button was not pressed within the time period specified in the Time to Auto Disarm Configuration setting.  Therapy cable not attached. Pads/paddles connection compromised.	No action required. If desired, charge the device and press the Shock button.  Make sure the therapy cable is connected and the pads/paddles are making proper contact with the patient.
<b>Maximum Energy 50J</b> message.	Attempted delivery of greater than 50J using internal paddles.	Only energies up to 50J are available for internal defibrillation. Select a lower energy.
<b>No Shock Delivered, Replace Pads Now</b> message.	Faulty pads or poor pads application to patient. (Low impedance.)	Make sure pads are applied properly. If the problem persists, replace the pads.
<b>No Shock Delivered, Press Pads Firmly</b> message.	Poor pads contact with the patient. (High impedance.)	Make sure pads are applied properly. Firmly press pads on the patient's chest.
<b>No Shock Delivered, Low/High Impedance</b> message.	Poor paddles contact with patient skin.  Paddles failure.	Make sure paddles are making adequate contact with the patient's skin. If the problem persists, replace the paddles.
<b>Pacer Equip Malfunction</b> INOP.	Pacing hardware failure.	Call for service. If pacing functionality is essential to patient care, take the device out of use.

Table 69 Defibrillation and Pacing Problems (Continued)

Symptom	Possible Cause	Possible Solution
<b>Press Charge Before Shock</b> message.	The device is not charged to the selected energy.	Make sure the desired energy is selected. Then press the Charge button.
<b>Press Shock Buttons on Paddles</b> message.	The Shock button on the device is disabled because external paddles or switched internal paddles are connected.	Press the Shock button(s) on the paddles to deliver a shock.
<b>R-Wave Not Detected</b> message.	During synchronized cardioversion, the r-wave was not detectable.	Choose a lead with a clearly define QRS complex.
<b>Pacing Stopped. [Leads Off]</b> message.	Pacing has stopped because the ECG source for Wave Sector 1 has become invalid because of a Leads Off condition or an ECG cable disconnection.	Check that the monitoring electrodes are applied properly to the patient. Check cable connections. Press the <b>[Resume Pacing]</b> soft key to continue pacing.
<b>Pacing Stopped. [Pads Off] [Pads Cable Off]</b> message.	Pacing has stopped because of poor pads/patient contact or a pads cable disconnection.	Check that the pads are applied correctly to the patient. Check cable connections. Press the <b>[Resume Pacing]</b> soft key to continue pacing.
<b>Shock Button Failure</b> INOP	During an Operational Check, when the Shock button was pressed, there was no response.	Remove the device from use and call for service.
<b>Therapy Knob Failure</b> INOP	During an Operational Check, the Therapy Knob test failed.	Remove the device from use and call for service.
Time to charge to selected energy is slow.	The device is being operated with only AC/DC power (no battery) or the battery power is low.	Install a fully charged battery.
Device displays a <b>No Shock Delivered</b> message but you see a physiological response from the patient	Poor skin contact; pads are not properly connected to the patient. Minimal patient movement is possible in this situation as the defibrillator may deliver a small amount of energy. The shock counter will remain at zero.	<ul style="list-style-type: none"> <li>• Make sure the pads are applied properly.</li> <li>• Replace pads in necessary</li> </ul>

Table 70 Printer Problems

Symptom	Possible Cause	Possible Solution
Paper won't move.	Paper improperly loaded or jammed, or paper is wet.	Reload paper or clear jam. If paper is wet, replace with fresh, dry roll.
Paper moves then stops.	<ul style="list-style-type: none"> <li>Door improperly latched.</li> <li>Paper improperly loaded or jammed.</li> </ul>	<ul style="list-style-type: none"> <li>Check door latch.</li> <li>Reload paper or clear jam.</li> </ul>
Paper moves but printing is faint or absent.	<ul style="list-style-type: none"> <li>Paper roll improperly installed.</li> <li>Incorrect paper type.</li> <li>Printhead temperature approaching maximum recommended operating temperature.</li> </ul>	<ul style="list-style-type: none"> <li>Check that the paper is installed correctly.</li> <li>Use only recommended paper type.</li> <li>Wait until the printer cools down and restart printing.</li> </ul>
Paper moves but print quality poor or some dots missing.	Dirty printhead.	Clean the printhead.
Loud buzzing or grinding noise.	Door improperly latched.	Check door latch.
White line running along paper.	Dirt on printhead.	Clean the printhead.
<b>Incompatible Printer</b> message.	The installed printer does not support the fonts required. Asian fonts require the 75 mm printer.	<ul style="list-style-type: none"> <li>Install the 75 mm printer.</li> </ul>
<b>Check Printer</b> message.	The printer is out of paper or the door is open.	<ul style="list-style-type: none"> <li>Load/reload the printer paper.</li> <li>Make sure the printer door is closed.</li> </ul>
<b>Printer Malfunction</b> message.	The printer is faulty or there is a problem communicating with the printer.	Turn the HeartStart MRx off for 15 seconds and then turn it on again. If the problem persists, call for service. If printing is essential to patient care, take the device out of use.
<b>Printer Temperature High</b> message.	The temperature of the print head exceeds the recommended operating temperature.	Wait until the printer cools down and restart printing.

Table 71 Data Card Problems

Symptom	Possible Cause	Possible Solution
<b>Incompatible Data Card</b> message.	Data card is not compatible with the HeartStart MRx.	Use only compatible Data Cards. For a listing of compatible Data Cards see Maintenance chapter.
<b>Data Card Full</b> message.	The data card has reached capacity.	Insert new data card or erase data from card.
<b>No Data Card Present</b> message.	<p>A data card is not inserted in the device.</p> <p>Sufficient time not allowed for data card recognition.</p>	Insert data card. Once inserted, wait 5 seconds before trying to access the data card.

Table 72 Invasive Pressure Monitoring Problems

Symptom	Possible Cause	Possible Solution
Invasive Pressure wave not displayed	The sensor is not properly connected or the sensor cable is damaged.  The pressure waveform is not configured to be displayed and there is not an unused wave sector.	<ul style="list-style-type: none"> <li>Check the sensor connection and cable.</li> <li>Try another sensor.</li> </ul> Use the <b>Displayed Waves</b> menu to select a wave sector for display of the pressure waveform.
<b>CPP Check Sources</b> INOP	The ICP and/or arterial pressure used to derive CPP is invalid.	Make sure ICP and arterial pressure cables are connected to the device and zeroed.
<b>Invasive Pressure Label Artifact</b> INOP	The device has detected a pressure change. A resulting alarm, most likely a high limit alarm, will be suppressed.	In the event you do not think you created a non-physiological event, check cable and tubing. Rezero and try again.
<b>Invasive Pressure Label Equip Malfunction</b> INOP	There has been a malfunction in the Invasive Pressure hardware.	Contact Service.
<b>Invasive Pressure Label Noisy Signal</b> INOP	This can only occur when pulse is determined from a pressure wave. The pulse rate is higher than 350 bpm. May be caused by movement artifact or electrical interference.	Stop movement.  Minimize possible electrical interference.
<b>Invasive Pressure Label Non-pulsatile</b> INOP	This can only occur when pulse is determined from a pressure wave. The pulse rate is less than 25 bpm or the amplitude of the pressure wave is less than 3 mmHg.	Check the catheter and connections to the patient.
<b>Invasive Pressure Label Overrange</b> INOP	The pressure wave is outside the measurement range.	Make sure the measurement has been properly prepared and zeroed and that the transducer is level with the heart. If the INOP message persists, try another transducer. Make sure the transducer is on the supported accessories list.
<b>Invasive Pressure Label Unplugged</b> INOP	The pressure transducer has been disconnected from the device or is faulty.	Try unplugging and then replugging the transducer. If the symptom does not go away, use a different transducer.
<b>Invasive Pressure Label Zero + Check Cal</b> INOP	Occurs when a new transducer is attached to the monitor.	Zero the transducer. Check the calibration factor, if applicable.
<b>Check Scale</b> displayed with pressure waveform	The wave is clipped in the displayed wave area.	Change the scale.
<b>Unable to Zero</b> message	The cause is displayed with the message.	Depends on the cause.
<b>Unable to Calibrate</b> message	The cause is displayed with the message.	Depends on the cause.
<i>Invasive Pressure Label</i> = one of the labels which can be applied to an Invasive Pressure pressure channel.		

Table 73 Temperature Monitoring Problems

Symptom	Possible Cause	Possible Solution
<b>Temperature Label Equip Malfunction</b> INOP	There has been a malfunction in the temperature hardware.	Contact Service.
<b>Temperature Label Overrange</b> INOP	The temperature value is outside the measurement range of the device (<0°C or > 45°C).	Check that the temperature probe is on the list of supported accessories. Try changing the application site.
<b>Temperature Label Unplugged</b> INOP	The temperature transducer is faulty or has been disconnected from the device.	Try unplugging and then replugging the temperature transducer. If the symptom does not go away, use a different transducer.
<i>Temperature Label</i> = one of the labels which can be applied to a temperature measurement.		

Table 74 Pulse Problems

Symptom	Possible Cause	Possible Solution
<b>Pulse Check Source</b> INOP	The currently selected pulse source is not available but another possible pulse source is on.	Switch to the secondary pulse source.
See SpO <sub>2</sub> Table 65 and Invasive Pressures Table 72 for further troubleshooting information.		

Table 75 Q-CPR Problems

Symptom	Possible Cause	Possible Solution
<b>CPR Sensor Malfunction</b> INOP.	The Compression Sensor power-on self-test has failed.	Check the Compression Sensor and cable connections. If necessary, replace the Compression Sensor.
<b>CPR Sensor Unplugged</b> INOP.	<ol style="list-style-type: none"> <li>1. The Compression Sensor is unplugged.</li> <li>2. The device cannot communicate with the Compression Sensor.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check the Compression Sensor and cable connections.</li> <li>2. Replace the Compression Sensor.</li> </ol>
<b>CPR Sensor Inverted</b> INOP.	The Compression Sensor is not positioned correctly. It is upside down.	Correctly apply the Compression Sensor to the patient. See “Placing the Compression Sensor on the Patient” on page 169.
<b>Poor Pads Contact</b> INOP.	Thoracic impedance measured at >140 Ohms, therefore, the signal is not valid for ventilation detection.	Make sure the Pads/CPR cable is connected and pads are properly applied in an anterior/anterior position. If necessary, prepare the patient’s skin and apply new pads.
<b>Pads Off</b> INOP.	Pads are not making proper contact with the patient.	Make sure the Pads/CPR cable is connected and pads are properly applied in an anterior/anterior position. If necessary, prepare the patient’s skin and apply new pads.
<b>Cannot Analyze Vent</b> INOP.	<p>Spontaneous respiration indicated by a change in the impedance signal of &gt; 3 Ohms.</p> <p>Excessive noise on the impedance signal.</p>	<p>Assess the patient for the return of spontaneous respiration. If present, discontinue CPR.</p> <p>Make sure the Pads/CPR cable is connected and pads are properly applied. If necessary, prepare the patient’s skin and apply new pads.</p>



## Audio Tones and Alarm Indications

The following table describes the audio tones and alarm indications, when they occur, and their meaning.

**NOTE** Alarm tone volume levels exceed 60 dB. See the HeartStart MRx *Service Manual* for alarm signal pressure ranges.

**Table 76 Audio Tones**

Tone/Indication	Definition
Single beep.	Message tone. Accompanies a new message on the display. Informational such as switching to the other battery.
Continuous tone, lower pitch than charged tone.	Charging tone. Generated when the Charge button is pressed and continues until the device is fully charged.
Continuous tone.	Charged tone. Generated when the selected defibrillation energy is reached and continues until the Shock button is pressed, the <b>[Disarm]</b> soft key is pressed, or the device disarmed automatically after the configured time had elapsed since pressing the Charge button.
Periodic chirp.	Low battery or RFU failure. Repeated periodically while the condition exists.
Continuous tone, alternating pitch.	Device will shut down in one minute.
Tone repeated once a second. Red alarm indicator message for applicable HR/arrhythmia, apnea, extreme desat and pressure disconnect alarms.	<b>Philips' Red Alarm Tone:</b> Generated while at least one red alarm is occurring.
High pitched tone repeated five times followed by a pause. Red alarm indicator message for applicable HR/arrhythmia, apnea, extreme desat and pressure disconnect alarms.	<b>IEC Red Alarm Tone:</b> Generated while at least one red alarm is occurring.
Tone repeated every two seconds, lower pitch than red alarm tone. Yellow alarm indicator message for applicable HR/arrhythmia, SpO <sub>2</sub> , NBP, Invasive Pressures, Temperature, Pulse and EtCO <sub>2</sub> alarms.	<b>Philips' Yellow Alarm Tone:</b> Generated while at least one yellow alarm is occurring.

Tone/Indication	Definition
Lower pitched tone is repeated three times, followed by a pause. Yellow alarm indicator message for applicable HR/arrhythmia, SpO <sub>2</sub> , NBP, Invasive Pressures, Temp, Pulse and EtCO <sub>2</sub> alarms.	<b>IEC Yellow Alarm Tone:</b> Generated while at least one yellow alarm is occurring
Tone repeated every two seconds, lower pitch then yellow alarm tone. Cyan indicator message.	<b>Philips' INOP Tone:</b> Generated while at least one INOP condition is occurring.
Lower pitched tone is repeated twice, followed by a pause. Cyan indicator message.	<b>IEC INOP Tone:</b> Generated while at least one INOP condition is occurring.
Tone occurring synchronously with each heart beat.	QRS tone.

## Calling for Service

For telephone assistance, call the Response Center nearest to you, or visit our website at: [www.medical.philips.com/cms](http://www.medical.philips.com/cms) and follow the links for “CMS Response Center.”

**Table 77 Response Center Phone Numbers**

<b>North America</b>	
Canada	800-323-2280
United States of America	800-722-9377
<b>Europe</b>	
European International Sales	41 22 354 6464
Austria	01 25125 333
Belgium	02 778 3531
Finland	010 855 2455
France	0803 35 34 33
Germany	0180 5 47 50 00
Italy	800 825087
Netherlands	040 278 7630
Sweden	08 5064 8830
Switzerland	0800 80 10 23
United Kingdom	0870 532 9741
<b>Asia/Asia Pacific</b>	
Australia	1800 251 400
China (Beijing)	800 810 0038
Hong Kong Macau	852 2876 7578 0800 923
India New Delhi Mumbai Calcutta Chennai Bangalore Hyderabad	011 6295 9734 022 5691 2463/2431 033 485 3718 044 823 2461 080 5091 911 040 5578 7974
Indonesia	021 794 7542
Japan	0120 381 557
Korea	080 372 7777 02 3445 9010
Malaysia	1800 886 188
New Zealand	0800 251 400
Philippines	02 845 7875
Singapore	1800 PHILIPS
Thailand	02 614 3569
Taiwan	0800 005 616



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# Specifications and Safety

This chapter describes the specifications and safety features of the HeartStart MRx monitor/defibrillator.

## Specifications

### General

**Dimensions with pads** 31.5 cm (W) x 21.0 cm (D) x 29.5 cm (H); (12.4 in. x 8.3 in. x 11.7 in.)

**Dimensions with paddles** 34.0 cm (W) x 21.0 cm (D) x 34.5 cm (H); (13.4 in. x 8.3 in. x 13.6 in.)

**Weight** Less than 13.2 lbs. including pads, pads cable, battery, and full roll of paper. Incremental weight of external standard paddles and paddle tray is less than 2.5 lbs. Additional battery weighs less than 1.6 lbs.

**Standard Operator Position** Within one meter of device.

### Defibrillator

**Waveform** Biphasic Truncated Exponential. Waveform parameters adjusted as a function of patient impedance.

**Shock Delivery** Via multifunction electrode pads or paddles.

## Delivered Energy Accuracy

Selected Energy	Nominal Delivered Energy vs. Patient Impedance							Accuracy
	Load Impedance (ohms)							
	25	50	75	100	125	150	175	
1J	1.2	1.3	1.2	1.1	1.0	0.9	0.8	±2J
2J	1.8	2.0	2.0	1.9	1.7	1.6	1.5	±2J
3J	2.8	3.0	3.0	3.1	3.0	2.9	2.7	±2J
4J	3.7	4.0	4.0	4.1	4.2	4.2	4.0	±2J
5J	4.6	5.0	5.1	5.1	5.2	5.2	5.0	±2J
6J	5.5	6.0	6.1	6.2	6.3	6.3	6.1	±2J
7J	6.4	7.0	7.1	7.2	7.3	7.3	7.1	±2J
8J	7.4	8.0	8.1	8.2	8.4	8.3	8.1	±2J
9J	8.3	9.0	9.1	9.3	9.4	9.4	9.1	±2J
10J	9.2	10	10	10	10	10	10	±2J
15J	14	15	15	15	16	16	15	±15%
20J	18	20	20	21	21	21	20	±15%
30J	28	30	30	31	31	31	30	±15%
50J	46	50	51	51	52	52	50	±15%
70J	64	70	71	72	73	73	71	±15%
100J	92	100	101	103	104	104	101	±15%
120J	110	120	121	123	125	125	121	±15%
150J	138	150	152	154	157	156	151	±15%
170J	156	170	172	175	177	177	172	±15%
200J	184	200	202	206	209	209	202	±15%

## Charge Time:

- Less than 5 seconds to 200 Joules with a new, fully charged Lithium Ion battery pack at 25°C.
- Less than 15 seconds when operating without a battery, using the M3539A AC power module alone at 90-100% rated mains voltage.
- Less than 15 seconds with a new, fully charged Lithium Ion battery pack at 25°C, depleted by up to 15 200 Joule discharges.
- Less than 25 seconds from initial power on, with a new, fully charged Lithium Ion battery pack at 25°C, depleted by up to 15 200 Joule discharges.
- Less than 25 seconds from initial power on when operating without a battery, using the M3539A AC power module alone at 90-100% rated mains voltage.
- Less than 30 seconds from initiation of rhythm analysis (AED Mode) with a new, fully charged Lithium Ion battery pack at 25°C, depleted by up to 15 200 Joule discharges.
- Less than 30 seconds from initiation of rhythm analysis (AED Mode) when operating without a battery, using the M3539A AC power module alone at 90-100% rated mains voltage.

- Less than 40 seconds from initial power on (AED Mode) with a new, fully charged Lithium Ion battery pack at 25°C, depleted by up to 15 200 Joule discharges.
- Less than 40 seconds from initial power on (AED Mode) when operating without a battery, using the 3539A AC power module alone at 90-100% rated mains voltage.

**Patient Impedance Range:** Minimum: 25 Ohm (external defibrillation); 15 Ohm (internal defibrillation); Maximum: 180 Ohm

Note: Actual functional range may exceed the above values.

## Manual Defib Mode

**Manual Output Energy (Selected):** 1-10, 15, 20, 30, 50, 70, 100, 120, 150, 170, 200 Joules; maximum energy limited to 50J with internal paddles

**Controls:** On/Off Therapy Knob, Charge, Shock, Sync, ECG Lead Select, Disarm, Print, Mark Event, Alarm Pause, Event Review

**Energy Selection:** Front panel Therapy Knob

**Charge Control:** Front panel button, button on external paddles

**Shock Control:** Front panel button, buttons on external or switched internal paddles

**Synchronized Control:** Front panel SYNC button

**Indicators:** Text Prompts, Audio Alerts, QRS Beeper, Battery Status, Ready For Use, External Power, Sync Mode

**Armed Indicators:** Charging/charged tones, flashing shock button, energy level indicated on display

## AED Mode

**AED Energy Profile:** 150 Joules nominal into a 50 ohm test load

**AED Controls:** On/Off, shock

**Text and Voice Prompts:** Extensive text/audible messages guide user through configured protocol.

**Indicators:** Monitor display messages and prompts, voice prompts, battery status, Ready For Use, external power

**Armed Indicators:** Charging/charged tones, flashing shock button, energy level indicated on display

**ECG Analysis:** Evaluates patient ECG and signal quality to determine if a shock is appropriate and evaluates connection impedance for proper defibrillation pad contact

**Shockable Rhythms:** Ventricular Fibrillation with amplitude >100  $\mu$ V and shockable wide-complex tachycardias. Shockable tachycardias include wide-complex rhythms of ventricular or unknown origin with heart rate greater than 150 bpm and polymorphic ventricular tachycardia at any heart rate.

**Shock Advisory Algorithm Sensitivity and Specificity:** Meets AAMI DF-39

Table 78 AED ECG Analysis Performance

Rhythm Class	ECG Test Sample Size <sup>a</sup>	Nominal Specifications
Shockable Rhythm Ventricular Fibrillation	600	Meets AAMI DF39 requirement and AHA recommendation <sup>b</sup> (sensitivity > 90%) for adult defibrillation
Shockable Rhythm Ventricular Tachycardia	300	Meets AAMI DF39 requirement and AHA recommendation <sup>b</sup> (sensitivity > 75%) for adult defibrillation
Non-shockable Rhythm Normal Sinus Rhythm	250	Meets AAMI DF39 requirement (specificity > 95%) and AHA recommendation <sup>b</sup> (specificity > 99%) for adult defibrillation
Non-shockable Rhythm Asystole	500	Meets AAMI DF39 requirements and AHA recommendation <sup>b</sup> (specificity > 95%) for adult defibrillation
Non-shockable Rhythm All other non-shockable rhythms	600	Meets AAMI DF39 requirements and AHA recommendation <sup>b</sup> (specificity > 95%) for adult defibrillation

- a. From Philips Medical Systems ECG rhythm databases.
- b. American Heart Association (AHA) AED Task Force, Subcommittee on AED Safety & Efficacy. Automatic External Defibrillators for Public Access Use: Recommendations for Specifying and Reporting Arrhythmia Analysis Algorithm Performance, Incorporation of New Waveforms, and Enhancing Safety. American Heart Association (AHA) AED Task Force, Subcommittee on AED Safety & Efficacy. *Circulation* 1997;95:1677-1682.

## ECG and Arrhythmia Monitoring

**Inputs:** Up to four (4) ECG waves may be viewed on display and up to two (2) waves printed simultaneously. Lead I, II, or III is obtained through the 3-wire ECG cable and separate monitoring electrodes. With a 5-lead ECG cable, leads aVR, aVL, aVF, and V can also be obtained. Pads ECG is obtained through 2 multifunction electrode pads.

**Lead Fault:** LEAD OFF message and dashed line appear on the display if an electrode or lead becomes disconnected.

**Pad Fault:** Dashed line appears on the display if a pad becomes disconnected.

**Heart Rate Display:** Digital readout on display from 15 to 300 bpm, with an accuracy of  $\pm 10\%$

**Heart Rate/Arrhythmia Alarms:** HR, Asystole, VFIB/VTACH, VTACH, Extreme Tachy, Extreme Brady, PVC rate, Pacer Not Capture, Pacer Not Pacing

**Common Mode Rejection:** Greater than 90 dB measured per AAMI standard for cardiac monitors (EC 13)

**ECG Size:** 2.5, 5, 10, 20, 40 mm/mV, autogain

**Maximum T wave amplitude:** Meets recommended minimum 1.2mV T-wave amplitude rejection.



**Frequency Response:**

- AC Line Filter - 60 Hz or 50 Hz
- Pads ECG for Display: Monitor - (.15-40 Hz) or EMS (1-30 Hz)
- Pads ECG for Printer - Monitor (.15-40 Hz) or EMS (1-30 Hz)
- Leads ECG for Display - Monitor (.15-40 Hz) or EMS (1-30 Hz)
- Leads ECG for Printer - Diagnostic (.05-150 Hz) or Monitor (.15-40 Hz) or EMS (1-30 Hz)

**Heart rate accuracy and response to irregular rhythm:** Meets AAMI standard for ventricular bigeminy (HR=80 bpm); slow alternating ventricular bigeminy (HR=60 bpm); rapid alternating ventricular bigeminy (HR=120 bpm); bidirectional systoles (HR=90 bpm)

**Heart rate averaging:** For heart rates  $\geq 50$  bpm, heart rate is determined by averaging the 12 most recent R-R intervals. Beats N, P and V are included. When heart rate drops below 50 bpm, the 4 most recent R-R intervals are used in the average. Note: For ventricular tachycardia alarms, which have a user-definable PVC run length limit, the heart rate is based on the user selected PVC length up to 9 PVCs maximum.

**Heart Rate Response Time:**

- 80 to 120 bpm: 7 seconds
- 80 to 40 bpm: 6 seconds

**Time to Alarm for Tachycardia:**

- 206 bpm (1 mV): 3 seconds
- 206 bpm (halved amplitude): 3 seconds
- 206 bpm (doubled amplitude): 3 seconds
- 195 bpm (2 mV): 3 seconds
- 195 bpm (halved amplitude): 3 seconds
- 195 bpm (doubled amplitude): 3 seconds

**Patient Isolation (defibrillation proof):**

- ECG: Type CF
- SpO<sub>2</sub>: Type CF
- EtCO<sub>2</sub>: Type CF
- NBP: Type CF
- Invasive Pressures: Type CF
- Temperature: Type CF
- External Defib: Type BF
- Internal Defib: Type CF

**Other Considerations:** The HeartStart MRx is suitable for use in the presence of electrosurgery. Burn hazard protection is provided via a 1K current limiting resistor contained in each ECG lead wire.

## Display

**Size:** 128 mm x 171 mm

**Type:** TFT Color LCD

**Resolution:** 640 x 480 pixels (VGA)

**Sweep Speed:** 25mm/s nominal (stationary trace; sweeping erase bar) for ECG, Invasive Pressure and SpO<sub>2</sub>; 6.25 mm/sec for CO<sub>2</sub>

**Wave Viewing Time:** 5 seconds (ECG)

## Battery

**Type:** 6.0 Ah, 14.8 V, rechargeable, Lithium Ion

**Dimensions:** 165 mm (H) x 95 mm (W) x 42 mm (D); (6.5 in. x 3.8 in. x 1.6 in)

**Weight:** Less than 1.6 lb. (0.73 kg)

**Charge Time with instrument off:** Approximately 3 hours to 100%. Approximately 2 hours to 80%, indicated by indicator. Charging the battery at temperatures above 45°C may degrade battery life.

**Capacity:** At least 5 hours of monitoring with ECG, SpO<sub>2</sub>, CO<sub>2</sub>, temperature and two invasive pressures monitored continuously, NBP measured every 15 minutes, and 20 200J discharges (with a new, fully charged battery, operating at room temperature, 25°C).

At least 3.5 hours of monitoring with ECG, SpO<sub>2</sub>, CO<sub>2</sub>, temperature and two invasive pressures monitored continuously, NBP measured every 15 minutes, and pacing at 180ppm at 160mA.

**Battery Indicators:** Battery gauge on battery, capacity indicator on display; flashing RFU indicator, chirp, and LOW BATTERY message appears on display for low battery condition\*

\*When LOW BATTERY message first appears, there is still enough energy remaining for at least 10 minutes of monitoring time and six maximum energy discharges (with a new battery at room temperature, 25°C).

**Battery Storage:** Storing the battery for extended periods at temperatures above 40°C will reduce battery capacity and degrade battery life.

## Thermal Array Printer

**Continuous ECG Strip:** The Print key starts and stops the strip. The printer can be configured to run real time or with a 10-second delay. The strip prints the primary ECG lead and a second or third wave (75mm printer only) with event annotations and measurements.

**Auto Printing:** The printer can be configured to automatically print on Mark Events, Charge, Shock, and Alarm. When an alarm condition occurs, the unit prints the Primary ECG wave, the alarming wave, if configured, and a third wave (75mm printer only).

**Reports:** The following can be printed:

- Event Summary (short, medium, and long)
- Vital Sign Trends
- 12-Lead
- Operational Check
- Configuration
- Status Log
- Device Information

**Speed:** 25 or 50 mm/s with an accuracy of  $\pm 5\%$

**Amplitude Accuracy:**  $\pm 5\%$  or  $\pm 40$  uV, whichever is greater

**Paper Size:**

- 50 mm (W) x 30 m (100 ft.) (L)
- 75 mm (W) x 30 m (100 ft.) (L)

## Noninvasive Pacing

**Waveform:** Monophasic Truncated Exponential

**Current Pulse Amplitude:** 10 mA to 175 mA (5 mA resolution); accuracy 10% or 5 mA, whichever is greater

**Pulse Width:** 40 ms with  $\pm 10\%$  accuracy

**Rate:** 30 ppm to 180 ppm (10 ppm increments); accuracy  $\pm 1.5\%$

**Modes:** Demand or Fixed Rate

**Refractory Period:** 340 msec (30 to 80 ppm); 240 msec (90 to 180 ppm)

## SpO<sub>2</sub> Pulse Oximetry

**SpO<sub>2</sub> Measurement Range** 0-100%

**SpO<sub>2</sub> Resolution:** 1%

**SpO<sub>2</sub> Update Period:** 1-2 sec typical; maximum: ≤60 sec

**SpO<sub>2</sub> Accuracy with:**

- M1191A sensor - 1 standard deviation 70% to 100%, ± 2.0%
- M1192A sensor - 1 standard deviation 70% to 100%, ± 2.0%
- M1194A sensor - 1 standard deviation 70% to 100%, ± 3.0%
- M1195A sensor - 1 standard deviation 70% to 100%, ± 3.0%
- M1131A sensor - 1 standard deviation 70% to 100%, ± 3.0%
- M1903B sensor - 1 standard deviation 70% to 100%, ± 3.0%
- M1904B sensor - 1 standard deviation 70% to 100%, ± 3.0%

**NOTE** Accuracy outside the range indicated for each sensor is not specified. The above referenced sensors were validated for use with the HeartStart MRx using the Philips picoSAT II SpO<sub>2</sub> module with Fourier Artifact Suppression Technology (FAST). This module is not available as a stand-alone device.

**NOTE** Pulse oximeter equipment measurements are statistically distributed, therefore only two-thirds of pulse oximeter equipment measurements can be expected to fall within ±Arms of the value measured by a CO-oximeter. The HeartStart MRx is calibrated to display functional oxygen saturation.

**Ambient Light Sensitivity** Interference from fluorescent light is <2% SpO<sub>2</sub> perfusion between 0.3% and 1% typical transmission (50nA/mA), 10 to 1000 1x light intensity, 50Hz +/- 0.5Hz as well as 60Hz +/-0.5Hz line frequency.

**SpO<sub>2</sub> Alarm Range:**

Low Limit: 50 to 99% (Adult/Pediatric)

High Limit: 51 to 100% (Adult/Pediatric)

**SpO<sub>2</sub> and Pulse High/Low Alarm Signal Generation Delay:** 10 seconds

**SpO<sub>2</sub> Response Time (90 to 80%):** average 18.9 seconds, standard deviation 0.88 seconds

**SpO<sub>2</sub> Averaging Time:** 20 seconds

**Maximum Power Output:** ≤15mW

**Wavelength Range:** 500-1000nm (Information about wavelength range can be useful to clinicians, especially those performing photodynamic therapy.)

average 18.9 seconds; standard deviation 0.88 seconds

**Desat Alarm Signal Generation Delay:** 20 seconds

**Pulse Rate Measurement Range** 30-300 bpm

**Pulse Rate Resolution** 1bpm

**Pulse Rate Accuracy:** 2% or 1 bpm (whichever is greater) over the measurement range

**Pulse Alarm Range:**

Low Limit: 30 to 195 (Adult); 30 to 235 (Pediatric)

High Limit: 35 to 200 (Adult); 35-240 (Pediatric)

**Pulse Response Time (90 to 120 bpm):** average 18.0 seconds; standard deviation 0.86 seconds

## NBP

**Pressure Range:**

- Systolic: 40-260 mmHg
- Diastolic: 20-200 mmHg

**Pulse Rate Range:** 30 to 220 bpm

**Initial Pressure:** 160 mmHg Adult; 120 mmHg Pediatric

**Maximum Pressure:** 280 mmHg

**Overpressure Safety Limits:** Maximum of 300 mmHg

**Cuff Inflation Time:** 75 second maximum (pediatric or adult)

**Pressure Transducer Accuracy:**  $\pm 3$ mmHg

**Alarm Range:**

- Systolic high limit: 35-270 (Adult), 35-180 (Pediatric)
- Systolic low limit: 30-265 (Adult), 30-175 (Pediatric)
- Diastolic high limit: 15-245 (Adult), 15-150 (Pediatric)
- Diastolic low limit: 10-240 (Adult), 10-145 (Pediatric)
- Mean high limit: 25-255 (Adult), 25-160 (Pediatric)
- Mean low limit: 20-250 (Adult), 20-155 (Pediatric)

**Rated Life:** 50,000 measurement cycles (36/day for 2.3 years)

**Auto Mode Repetition Time:** 1, 2.5, 5, 10, 15, 30, 60, or 120 minutes

**Maximum Measurement Time:** 120 sec.

**Interconnect Tube Length:**

- M1598B Connect tubing 1.5 m
- M1599B Connect tubing 3.0 m

**Recommended frequency of pressure transducer calibration:** yearly

## Invasive Pressures

**Transducer Sensitivity:** 5 $\mu$ V/V mmHg (37.5 $\mu$ V/V/kPa)

**Sensitivity Adjustment Range:**  $\pm$ 10%

**Transducer Load Resistance:** 195 to 2200 Ohms

**Transducer Output Resistance:** 0 to 3000 Ohms

**Frequency Response:** 0-12Hz or 0-40Hz

**Zero Adjustment Range:**  $\pm$ 200mmHg ( $\pm$ 26.7kPa)

**Zero Adjustment Accuracy:**  $\pm$ 1.0mmHg ( $\pm$ 0.1kPa)

**Zero Setting Drift:** <0.1mmHg/ $^{\circ}$ C (0.013kPa/ $^{\circ}$ C)

**Gain accuracy (excluding transducers):**  $\pm$ 1% of reading or 1mmHg (0.1kPa) whichever is greater

**Gain Drift:** less than 0.05%/ $^{\circ}$ C

**Overall Accuracy (included listed transducers):**  $\pm$ 4% of reading or 4mmHg (0.5kPa) whichever is greater

**Measurement Range:** -40 to 361mmHg (-5.3 to 48.1kPa)

**Measurement Resolution:** 1mmHg (0.1kPa)

**Noise:** <1mmHg (0.1kPa)

**Alarm Response Time (60 bpm - transition from 120/0 to 25/0):** 11.1 seconds; standard deviation 0.001 seconds

**Alarm Signal Generation Delay:**  $\leq$  14 seconds after an INOP condition for that pressure channel clears or 8 seconds in the absence of an INOP for that pressure channel.

**Transducer/Dome Volume Displacement:** Refer to the specific device's specifications.

**Additional Noise from EMI if operating under conditions according to EMC standard EN60601-1-2 (Radiated Immunity 3 V/m or Conducted Immunity 3 VRMS):**  $\leq$ 3mmHg

**Pulse Rate Range:** 25-350 bpm

**Pulse Rate Accuracy:** 1% of full range

**Pulse Rate Resolution:** 1 bpm

## Temperature

**Measurement Range:** 0°- 45°C (32 - 113°F)

**Measurement Resolution:** 0.1°C (0.2°F)

**Measurement Accuracy (excluding any adapter cable):**  $\pm 0.1^\circ\text{C}$  from 25°C to 45°C;  $\pm 0.3^\circ\text{C}$  from 0°C to 24.9°C (temperature probe adds an additional  $\pm 0.1^\circ\text{C}$ )

**Settling Time Constant:** <10 seconds

**Alarm Signal Generation Delay:** 5 seconds

**Averaging Time:** 1 second

**Minimum measurement time:** See the probe's *Instructions for Use* to obtain minimum measurement times for accurate readings. The HeartStart MRx does not add any clinically significant time to obtain accurate readings.

## EtCO<sub>2</sub>

**Range:** 0 to 99 mmHg at sea level

**Resolution:** 1 mmHg (0.1kPa)

**Accuracy:** For values between 0 and 38 mmHg:  $\pm 2$  mmHg. For values between 39 and 99 mmHg:  $\pm 5\%$  of reading + 0.08% for every 1 mmHg above 38 mmHg. Values read at sea level after  $\geq 20$  min warm up. For breath rates above 80 and EtCO<sub>2</sub> values > 18 mmHg, accuracy is 4mmHg or  $\pm 12\%$  of reading, whichever is greater.

**Drift of Measurement Accuracy:** Over any 24-hour period, the accuracy claims listed above are maintained.

The accuracy specification is maintained to within 4% for the following gas mixtures (all values are in Vol. %).

CO <sub>2</sub>	N <sub>2</sub>	O <sub>2</sub>	N <sub>2</sub> O	H <sub>2</sub> O	Anesthetic Agents
0 to 13	0 to 97.5	0 to 100	0 to 80	dry to saturated	According to EN21647

**Rise Time:** 190 ms maximum @ 10ml/min

**System Response Time (with a standard length FilterLine):** 2.9 seconds typical - includes the delay time and rise time (10% to 90%) in response to a step change in the CO<sub>2</sub> concentration

**Alarm Delay Time:** 5.2 seconds, standard deviation 0.08 seconds (includes the 2.9 second FilterLine delay).

**Sample Flow Rate:** Nominally 50 ml/min; - 7.5 to + 15 ml/min

**Microstream CO<sub>2</sub> Humidity Correction Factor:**

BTPS (Body Temperature and Pressure, Saturated - 37°C, 750mmHg, 100% humidity or 47mmHg) is the humidity correction factor for the Microstream CO<sub>2</sub> readings. Correction calculation formula:

$$P_{BTPS} = F_{CO_2} \times (P_b - 47) - F_{CO_2} \times 0.94$$

Where FCO<sub>2</sub> = fractional concentration of CO<sub>2</sub> in dry gas.

F<sub>CO<sub>2</sub></sub> = %CO<sub>2</sub>/100; P<sub>b</sub> = ambient pressure

**Alarm Range:**

- Low Limit: 10 to 94 mmHg (Adult/Pediatric)
- High Limit: 20 to 95 mmHg (Adult/Pediatric)

**AwRR**

**Range:** 0 to 150 rpm

**Resolution:** 1 rpm

**Accuracy:**

- 0 to 40 rpm ±1 rpm
- 41 to 70 rpm ±2 rpm
- 71 to 100 rpm ±3 rpm
- 101 to 150 rpm ± 5 rpm

**Alarm Range:**

- Low Limit: 0 to 95 rpm (Adult/Pediatric)
- High Limit: 10 to 100 rpm (Adult/Pediatric)

**Apnea Alarm Delay:** 10-40 seconds, in increments of 5

**Calibration Gas for CO<sub>2</sub> Measurement System**

**Ingredients:** 5% Carbon Dioxide, 21% Oxygen, 74% Nitrogen

**Cylinder Size:** BD

**Method of Preparation:** Gravimetric

**Blend Tolerance:** 0.03%

**Accuracy:** 0.03% absolute

**Moisture:** 10 PPM Maximum

**Expiration Period:** 2 years

**Pressure:** 144 PSIG, Volume: 10L



## 12-Lead ECG

**Inputs:** With a 10-lead cable, leads I, II, III, aVR, aVL, aVF, V/C1-V/C6 can be obtained. All 12-Lead ECG waves can be viewed on the display simultaneously. All 12 leads can be printed on the strip chart printer in 3x4 format.

## Patient Data Storage

**Internal Event Summary:** The internal Event Summary stores up to 12 hours of 2 continuous ECG waves, 1 CO<sub>2</sub> and 2 invasive pressure waves, events and trending per Event Summary. There is a maximum capacity of 55 Event Summaries or 240 megabytes (62 megabytes for those devices with a 64 megabyte card) of patient data, whichever comes first.

**Data Card Event Summary:** The Data Card has a maximum capacity of 60 Event Summaries or 240 megabytes (62 megabytes for those devices with a 64 megabyte card) of patient data, whichever comes first.

## Environmental (M3535A)

**Temperature:** 0°C to 45°C operating; -20° to 70°C storage

- Charging the battery at temperatures above 45°C may degrade battery life
- Storing the battery for extended periods at temperatures above 40°C will reduce battery capacity and degrade battery life

**Humidity:** Up to 95% Relative Humidity

- Printer paper may jam if paper is wet
- Thermal Printer may be damaged if wet paper is allowed to dry while in contact with printer elements

**Altitude:**

- Operating: 0 to 15,000 ft (0 to 4,500 m)
- Storage: 0 to 15,000 ft (0 to 4,500 m)

**Shock:**

- Operating: Half-sine waveform, duration < 3 ms, acceleration > 145 g, 1 time on all six faces
- Non-operating: Trapezoidal waveform, acceleration ≥ 30 g, velocity change=742 cm/s ±10% on all six faces

**Vibration:**

- Operating: Random vibration, 0.30 Grms, 5-500 Hz for ≥10 minutes/axis PSD=0.0002 g<sup>2</sup>/Hz from 5 to 350 Hz, -6 dB/octave slope from 350 to 500 Hz
- Non-operating:
  - Random vibration, 2.41 Grms, 5-500 Hz for ≥10 minutes/axis PSD=0.02 g<sup>2</sup>/Hz from 5 to 100 Hz, -6 dB/octave slope from 100 to 137 Hz, 0 dB/octave slope from 137 to 350 Hz, -6 dB/octave slope from 350 to 500 Hz.
  - Swept sine vibration, (0.75 g [0 to peak] 5 to 500 Hz) resonant search, 1 octave/minute sweep rate, 5 minute resonant dwell at 4 resonances per axis.

**Water/Solids Resistance:**

Water Resistance: Meets EN60601-2-4. Water testing performed with cables connected to the device. IPX4 - when used with water resistant paddles (M3543A) the M3535A is protected against splashing water.

- Solids Resistance: IP2X.

EMC: Complies with the requirements of standard EN 60601-1-2:2001.

Safety: Complies with the requirements of applicable safety standards.

**Other Considerations:**

- The HeartStart MRx is not suitable for use in the presence of concentrated oxygen or a flammable anesthetic mixture with air, oxygen, or nitrous oxide.
- Hazards arising from software errors were minimized by the product's compliance with the software requirements contained in EN 60601-1-4:1996.

**Mode of Operation:** Continuous

**AC Line Powered:** 100 - 240 VAC, 50 - 60 Hz, 1 - 0.46 A (Class 1)

**Battery Powered:** 14.8 V Rechargeable, Lithium Ion

**DC Powered:**

- Input: 11-32 VDC, 11 A
- Output: 18 V, 5 A, 90 W

## Environmental (M3536A)

**Temperature:** 0°C to 45°C operating; -20° to 70°C storage

- Charging the battery at temperatures above 45°C may degrade battery life
- Storing the battery for extended periods at temperatures above 40°C will reduce battery capacity and degrade battery life

**Humidity:** Up to 95% Relative Humidity

- Printer paper may jam if paper is wet
- Thermal Printer may be damaged if wet paper is allowed to dry while in contact with printer elements

**Altitude:**

- Operating: 0 to 15,000 ft (0 to 4,500 m)
- Storage: 0 to 15,000 ft (0 to 4,500 m)

**Shock:**

- Operating: Half-sine waveform, duration < 3 ms, acceleration > 145 g, 1 time on all six faces
- Non-operating: Trapezoidal waveform, acceleration  $\geq 30$  g, velocity change=742 cm/s  $\pm 10\%$  on all six faces
- Bump: EN60068-2-29 Bump (Half-sine, 40 g peak, 6 msec duration, 1,000 bumps x 3 axes)
- Free Fall: IEC 68-2-32 Free Fall. Drops on all faces onto a steel surface (excluding bed rail hook)
  - 30 in. (76.2 cm) with carrying case
  - 16 in. (40.6 cm) without carrying case

**Vibration:**

- Operating: MIL STD 810E 514.4 Category 6 Helicopter, General Storage, UH60
- Non-Operating:
  - IEC 68-2-6 Vibration (sinusoidal) (10-57 Hz  $\pm 0.15$ mm; 58-150 Hz, 2g; 20 sweeps x 3 axes)
  - IEC 68-2-64 Vibration, broad-band random (10-20 Hz, 0.05 g<sup>2</sup>/Hz; 20-150 Hz, -3 dB/octave; 150 Hz, 0.0065 g<sup>2</sup>/Hz; 1.5 hours x 3 axes)

**Solids/Water Resistance:** IP24. Water testing performed with cables connected to the device.

**EMC:** Complies with the requirements of standard EN 60601-1-2:2001.

**Safety:** Complies with the requirements of applicable safety standards.

**Other Considerations:**

- The HeartStart MRx is not suitable for use in the presence of concentrated oxygen or a flammable anesthetic mixture with air, oxygen, or nitrous oxide.
- Hazards arising from software errors were minimized by the product's compliance with the software requirements contained in EN 60601-1-4:1996.

**Mode of Operation:** Continuous

**AC Line Powered:** 100 - 240 VAC, 50 - 60 Hz, 1 - 0.46 A (Class 1)

**Battery Powered:** 14.8 V Rechargeable, Lithium Ion

**DC Powered:**

- Input: 11-32 VDC, 11 A
- Output: 18 V, 5 A, 90 W

## Symbol Definitions

Table 79 lists the meaning of each symbol shown on the HeartStart MRx and the M3538A battery.

**Table 79 Monitor/Defibrillator and Battery Symbols**












Symbol	Definition
	Defibrillation Shock.
	Attention - See operating instructions in Instructions for Use.
	Input.
	Output.
	Gas Sample Input.
	Gas Exhaust Output.
	Meets IEC type BF leakage current requirements and is defibrillator protected. (Patient Applied Part is isolated and defib-proof suitable for direct patient contact except the heart or major arteries.)
	Meets IEC type CF leakage current requirements and is defibrillator protected. (Patient Applied Part is isolated and defib-proof suitable for direct patient contact including the heart or major arteries.)
	Alarm Pause button
	Recyclable material.
	Dispose of in accordance to your country's requirements.

Table 79 Monitor/Defibrillator and Battery Symbols (Continued)







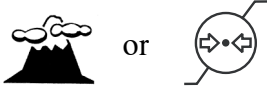
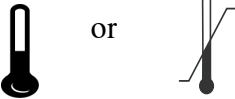
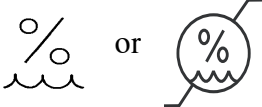




Symbol	Definition
IP24	Protected against ingress of solid foreign objects >12.5mm in diameter. Protected against access to hazardous parts with a finger. Protected against splashing water.
IP2X	Protected against ingress of solid foreign objects >12.5mm in diameter. Protected against access to hazardous parts with a finger.
	Data In/Out
	Electrostatic sensitive device
	Invasive Pressure Port (Number indicates Port 1 or Port 2)
	NBP port
	SpO <sub>2</sub> port
	Temperature port

Table 80 lists the meaning of the symbols that may appear on the shipping carton.

**Table 80 HeartStart MRx Shipping Carton Symbols**

	Atmospheric pressure range.
	Temperature range
	Relative humidity range.
	Recyclable paper product.
	Fragile.
	Right side up.
	Do not get wet.

# Units and Abbreviations

Table 81 lists units and abbreviations used with the HeartStart MRx.

**Table 81 Abbreviations**

Unit	Definition	Unit	Definition
bpm	beats per minute	cpm	compressions per minute
°C	degrees Celsius	sec	seconds
°F	degrees Fahrenheit	min	minutes
mmHg	millimeters of mercury	mm/mV	millimeter per millivolt
kPa	kilo Pascal	Hz	Hertz
%	percent	ppm	pulses per minute
rpm	respirations per minute	mA	milliAmpere
mm	millimeter	J	Joule



## Clinical Performance Summary - Defibrillation

An international, multicenter, prospective, randomized, clinical study was conducted to assess the effectiveness of the SMART Biphasic waveform in out-of-hospital sudden cardiac arrests (SCAs), as compared to monophasic waveforms. The primary objective of the study was to compare the percent of patients with ventricular fibrillation (VF) as the initial monitored rhythm that were defibrillated in the first series of three shocks or less.

This section summarizes the methods and results of this study.

### Methods

Victims of out-of-hospital SCA were prospectively enrolled in four emergency medical service (EMS) systems. Responders used either 150J SMART Biphasic AEDs or 200-360J monophasic waveform AEDs. A sequence of up to three defibrillation shocks were delivered. For the biphasic AEDs, there was a single energy output of 150J for all shocks. For monophasic AEDs, the shock sequence was 200, 200, 360J. Defibrillation was defined as termination of VF for at least five seconds, without regard to hemodynamic factors.

### Results

Randomization to the use of monophasic or SMART Biphasic automatic external defibrillators (AEDs) was done in 338 SCAs from four emergency medical service systems. VF was observed as the first monitored rhythm in 115 patients. The biphasic and monophasic groups for these 115 patients were similar in terms of age, sex, weight, primary structural heart disease, cause or location of arrest, and bystanders witnessing the arrest or performing CPR.

The 150J SMART Biphasic waveform defibrillated 98% of VF patients in the first series of three shocks or less, compared with 69% of patients treated with monophasic waveform shocks. Outcomes are summarized in Table 82.

**Table 82 Clinical Summary - Defibrillation**

	Biphasic Patients Number (%)	Monophasic Patients Number (%)	P Value (chi-square)
Defibrillation Efficacy			
- Single shock only	52/54 (96%)	36/61 (59%)	<0.0001
- ≤2 shocks	52/54 (96%)	39/61 (64%)	<0.0001
- ≤3 shocks	53/54 (98%)	42/61 (69%)	<0.0001
Patients Defibrillated	54/54 (100%)	49/58 (84%)	0.003
Return of Spontaneous Circulation	41/54 (76%)	33/61 (54%)	0.01
Survival to Hospital Admission	33/54 (61%)	31/61 (51%)	0.27
Survival to Hospital Discharge	15/54 (28%)	19/61 (31%)	0.69
CPC = 1 (Good)	13/15 (87%)	10/19 (53%)	0.04

### Conclusion

The 150J SMART Biphasic waveform defibrillated at higher rates than 200-360J monophasic waveforms, resulting in more patients achieving return of spontaneous circulation (ROSC) ( $p=0.01$ ). EMS system outcomes of survival discharge were not significantly different statistically. However, patients resuscitated with the lower energy SMART Biphasic waveform were more likely to have good cerebral performance (CPC, cerebral performance category) ( $p=0.04$ ).

# Clinical Performance Summary - Cardioversion

An international, multicenter, prospective, double-blinded, randomized, clinical trial was conducted to assess the effectiveness of the SMART Biphasic waveform in treatment of atrial fibrillation (AF), as compared to monophasic waveforms. The primary objective of the study was to determine the required energy for cardioversion of AF using the SMART Biphasic waveform, as compared with a monophasic damped sine waveform.

This section summarizes the methods and results of this study.

## Methods

Patients enrolled for this study were adults scheduled for elective cardioversion of AF at one of 11 clinical sites. Clinicians used both a defibrillator delivering the SMART Biphasic waveform, and one delivering a monophasic waveform. A sequence of up to five shocks was administered: four with the initial defibrillator, and a fifth cross-over shock was delivered with the other defibrillator if necessary. The sequence of energy settings was 100J, 150J, 200J through the first three shocks on either type of defibrillator. A fourth shock, if necessary, was delivered at 200J if the initial defibrillator was biphasic, and at 360J if the initial defibrillator was monophasic. The cross-over shock was 360J monophasic if the initial defibrillator was biphasic, and 200J biphasic if the initial defibrillator was monophasic. Successful cardioversion was defined as the occurrence of two P waves uninterrupted by atrial fibrillation within 30 seconds of the shock.

## Results

Randomization to the use of monophasic or SMART Biphasic defibrillators was done in 212 elective cardioversions involving 210 patients at eleven clinical sites in the United States and Europe. Of these, 203 results met the protocol criteria for inclusion in this analysis. The biphasic and monophasic groups were similar in terms of age, sex, weight, current medical history, cause of heart disease, and estimated ejection fraction.

The 150J SMART Biphasic waveform successfully converted far more patients with an initial 100J shock (60% compared with 22% for the monophasic waveform), and successfully converted patients at least as well with a maximum energy of 200J as the monophasic did with its maximum energy of 360J (91% compared to 85% for the monophasic waveform). Overall, the biphasic waveform required fewer shocks (1.7, compared to 2.8 for the monophasic waveform) and lower delivered energy (217J, compared to 548J for the monophasic waveform). Outcomes are summarized in Table 83.

Table 83 Clinical Summary - Cardioversion

	Biphasic Patients Number (%)	Monophasic Patients Number (%)	P Value
Cumulative Cardioversion Efficacy			
- Single shock only	58/96 (60%)	24/107 (22%)	<0.0001
- ≤2 shocks	74/96 (77%)	47/107 (44%)	<0.0001
- ≤3 shocks	86/96 (90%)	56/107 (53%)	<0.0001
- ≤4 shocks	87/96 (91%)	91/107 (85%)	0.29
Skin "burn"			
None	25/90 (28%)	15/105 (14%)	0.0001
Mild	50/90 (56%)	47/105 (45%)	
Moderate	15/90 (17%)	41/105 (39%)	
Severe	0/90 (0%)	2/105 (2%)	
Number of shocks	1.7 ± 1.0	2.8 ± 1.2	<0.0001
Cumulative delivered energy	217 ± 176J	548 ± 331J	<0.0001
Skin reaction definitions: (evaluated 24 - 48 hours after procedure)			
Mild - erythema, no tenderness			
Moderate - erythema, tenderness			
Severe - blistering or necrosis, tenderness			

## Conclusion

The SMART Biphasic waveform cardioverted at higher rates than the monophasic damped sine waveform at each step of the protocol, although the cumulative biphasic rate after 4 shocks was not significantly different from the monophasic rate. Tissue damage was more pronounced in the monophasic population.

# Clinical Performance Summary - Internal Defibrillation

## Overview

A study was conducted during the first half of 2002 to assess the effectiveness of the HeartStart MRx (biphasic) for use in intra-thoracic application, as compared to a control biphasic waveform. This appendix summarizes the methods and results of the study.

## Methods

Twelve swine, each weighing approximately 30 kg, were anesthetized and intubated. A sternotomy was performed to expose the heart. VF was induced electrically by 60 Hz current via a pacemaker catheter in the right ventricle. After 15 seconds of VF, a defibrillating shock was applied, using hand-held (2-inch diameter) "surgical" electrode paddles applied directly to the epicardium. Shock energies of 2, 5, 10, 20, and 30 J were used in random order. At least 4 shocks at each energy level were administered for 4 separate VF episodes to derive a "% success" data point at that energy. Success was defined as conversion of fibrillating rhythm to non-fibrillating rhythm five seconds after the shock.

## Results

The results showed that the average impedance was about 40 ohms in this study, which is similar to the human impedance data encountered in direct heart defibrillation. The efficacy results of the HeartStart MRx are shown in Table 84, along with historical efficacy results of a standard monophasic damped sine (MDS) waveform.<sup>1</sup>

**Table 84 Clinical Performance Summary - Internal Defibrillation**

	Energy				
	2J	5J	10J	20J	30J
HeartStart MRx (biphasic) Mean Success	4%	47%	77%	86%	88%
Sample Size	48	53	53	51	41
Control Biphasic Mean Success	10%	60%	93%	92%	92%
Sample Size	49	48	54	49	40
p-value Fisher's Exact (p<0.050)	0.436	0.232	0.032	0.526	0.712
Historical MDS Mean Success	3%	25%	34%	57%	76%

## Conclusion

Overall, the intra-thoracic defibrillation success rate for the HeartStart MRx (Biphasic) versus a control biphasic waveform had no significant difference (p<0.05) except at 10J.

1. Zhang, Y., Davies R., Coddington W., Jones J., Kerber RE., Open Chest Defibrillation: Biphasic versus Monophasic Waveform Shocks, JACC 2001;37;320A.

# Safety Considerations

The following general warnings and cautions apply to use of the HeartStart MRx. Additional warning and cautions specific to a particular feature are provided in the appropriate section.

## General

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**WARNING** The HeartStart MRx is not intended to be deployed in settings or situations that promote use by untrained personnel. Operation by untrained personnel can result in injury or death.

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**WARNING** HeartStart MRx service should only be performed by qualified service personnel, in accordance with the *HeartStart MRx Service Manual*.

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**WARNING** Use of the HeartStart MRx is restricted to a single patient at a time.

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**WARNING** When transporting the HeartStart MRx, it is important to position it with the display facing away from the body. If not, the Therapy Knob may be bumped and inadvertently moved from its current position.

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**WARNING** Remain attentive to the patient during the delivery of therapy. Delay in delivering a shock may result in a rhythm that was analyzed as shockable converting spontaneously to non-shockable and could result in inappropriate delivery of a shock.

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**WARNING** Use only 3-wire AC power cords with 3-pronged grounded plugs.

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**WARNING** Never operate the HeartStart MRx in standing water. Do not immerse, or pour fluids on, any portion of the HeartStart MRx. If the device does get wet, dry the device with a towel.

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**WARNING** Do not use the HeartStart MRx in the presence of a flammable anesthetic mixture or oxygen concentrations greater than 25% (or partial pressures greater than 27.5 kPa/206.27 mmHg). This can cause an explosion hazard.

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**WARNING** Avoid connecting the patient to several devices at once. Leakage current limits may be exceeded. Do not use a second defibrillator on the patient while pacing with the HeartStart MRx.

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**WARNING** Electric shock hazards exist internally. Do not remove assembly screws except as described in the carry bag assembly procedure. Refer servicing to qualified personnel.

---

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**WARNING** Operating the HeartStart MRx or its accessories in conditions outside the environmental specifications can result in device or accessory malfunction. The HeartStart MRx should be allowed to stabilize within the operating temperature range for 30 minutes prior to operation.

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**WARNING** Avoid touching monitoring electrodes and other measuring devices when they are applied to the patient. Doing so can degrade safety and may affect results.

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**WARNING** Do not touch communication ports and a patient simultaneously.

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**CAUTION** Do not discharge the defibrillator with the paddles shorted together.

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**CAUTION** Conductive parts of electrodes and associated connectors for applied parts, including the neutral electrode, should not contact other conductive parts including earth.

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**CAUTION** This device is suitable for use in the presence of high-frequency surgical equipment. Following electrosurgery interference, the equipment returns to the previous operating mode within 10 seconds without loss of stored data. Measurement accuracy may be temporarily decreased while performing electrosurgery or defibrillation. This does not affect patient or equipment safety. See the electrosurgery device's *Instructions for Use* for information on reducing hazards of burns in the event of a defect in its equipment. Do not expose the equipment to x-ray or strong magnetic fields (MRI).

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**CAUTION** Be aware of patient cables, including ECG monitoring equipment when used with high frequency surgical equipment.

---

**NOTE** This device and its accessories are not intended for home use.

**NOTE** The HeartStart MRx can be operated with only AC/DC power, only 14V M3538A Lithium Ion Battery, or AC/DC power and M3538A battery simultaneously.

**NOTE** For operation in the U.S., the AC power cord must have the proper NEMA type plug.

**NOTE** The HeartStart MRx does not require the practice of any special ElectroStatic Discharge (ESD) precautionary procedures.

## Defibrillation

---

**WARNING** Keep hands and feet clear of paddle electrode edges. Use your thumbs to depress the shock buttons on the paddle handle.

---

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**WARNING** Do not allow multifunction electrode pads to touch each other or to touch other ECG monitoring electrodes, lead wires, dressings, etc. Contact with metal objects may cause electrical arcing and patient skin burns during defibrillation and may divert current away from the heart.

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**WARNING** During defibrillation, air pockets between the skin and multifunction electrode pads may cause patient skin burns. To help prevent air pockets, make sure the pads completely adhere to the skin. Do not use dried out pads; do not open pads package until just prior to use.

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---

**WARNING** Never touch the patient or any equipment connected to the patient (including the bed or gurney) during defibrillation.

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**WARNING** Avoid contact between the patient and conductive fluids and/or metal objects, such as the gurney. Contact with metal objects could cause unintentional current pathways.

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**WARNING** Medical electrical equipment which does not incorporate defibrillator protection should be disconnected during defibrillation.

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**WARNING** In AED Mode, the multifunction electrode pads must be in the anterior-anterior position as shown on the packaging. The HeartStart MRx was not designed to assess data acquired from pads in an anterior-posterior position.

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## Battery

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**WARNING** Properly dispose of or recycle depleted batteries according to local regulations. Do not puncture, disassemble, or incinerate batteries.

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**WARNING** Built in safety circuits can not protect against handling abuse. Adhere to all warnings and cautions in handling and using lithium ion batteries.

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**WARNING** Do not expose batteries to temperatures greater than 60°C (140°F). Excess temperatures may result in battery damage.

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**WARNING** Keep batteries away from flame and other heat sources.

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**WARNING** Do not short circuit the battery. Avoid placing batteries around metal objects that may short circuit the battery.

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**WARNING** Avoid getting batteries wet or using batteries in high humidity environments.

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**WARNING** Do not crush, dent or allow any deformation of the batteries.

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**WARNING** Do not disassemble or open batteries. Do no attempt to alter or bypass the safety circuit.

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**WARNING** Avoid extreme shock and vibration to the battery.

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**WARNING** Do not use or connect the battery to batteries of other chemistries.

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## Supplies and Accessories

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**WARNING** Use only the multifunction electrode pads, battery, and accessories as listed in this guide. Substitutions may cause the HeartStart MRx to function improperly.

---

**WARNING** Use multifunction electrode pads prior to their expiration date. Discard pads after use. Do not reuse pads. Do not use for more than 8 hours of continuous pacing.

---

## Electromagnetic Compatibility

When using the HeartStart MRx, electromagnetic compatibility with surrounding devices should be assessed.

A medical device can either generate or receive electromagnetic interference. Testing for electromagnetic compatibility EMC with and without the appropriate accessories has been performed according to the international standard for EMC for medical devices (IEC 60601-1-2). This IEC standard has been adopted in Europe as the European Norm (EN 60601-1-2).

The EMC standards describe tests for both emitted and received interference. Emission tests deal with interference generated by the device being tested.

---

**WARNING** Radio frequency (RF) interference from devices other than the HeartStart MRx may degrade performance of the HeartStart MRx. Electromagnetic compatibility with surrounding devices should be assessed prior to using the defibrillator.

Fixed, portable, and mobile radio frequency communications equipment can affect the performance of medical equipment. See Table 89 for the minimum recommended separation distance between RF communications equipment and the HeartStart MRx.

---

## Reducing Electromagnetic Interference

The HeartStart MRx and associated accessories may be susceptible to interference from other RF energy sources and continuous, repetitive, power line bursts. Examples of other sources of RF interference are medical devices, cellular products, information technology equipment and radio/television transmission. Should interference be encountered, as demonstrated by artifact on the ECG or dramatic variations in parameter measurement values, attempt to locate the source. Assess:

- Is the interference intermittent or constant?
- Does the interference occur only in certain locations?
- Does the interference occur only when in close proximity to certain medical devices?
- Do parameter measurement values change dramatically when the AC line cord is unplugged?

Once the source is located, attempt to attenuate the EMC coupling path by distancing the monitor/defibrillator from the source as much as possible. If assistance is needed, call your local service representative.

## Restrictions for Use

Artifact on the ECG and parameter waveforms caused by electromagnetic interference should be evaluated by a physician or physician authorized personnel to determine if it will negatively impact patient diagnosis or treatment.

## Emissions and Immunity


The HeartStart MRx is designed and tested to comply with the radiated and conducted emissions requirement of international and national standards IEC 60601-1-2:2001 and EN 60601-1-2:2002. See Tables 85 through 89 for detailed information regarding declaration and guidance.

---

**WARNING** The use of accessories, transducers and cables other than those specified may result in increased emissions or decreased immunity of the HeartStart MRx.

---

The list of cables, transducers, and other accessories with which Philips claims compliance with the emissions and immunity requirements of IEC standard 60601-1-2 are listed in “Supplies and Accessories” on page 243.

The local area network (LAN) connector of the HeartStart MRx is marked with the  label. The pins of connectors marked with this warning symbol should not be touched or connections made to until the following precaution is taken:

Discharge yourself to a conductive metal surface which is connected to earth ground before making connections or touching the marked connector.

All staff using the HeartStart MRx should be instructed on these precautionary measures in order to avoid damage to this sensitive medical equipment.

The EMC standards state that manufacturers of patient-coupled equipment must specify immunity levels for their systems. See Tables 85 through 88 for this detailed immunity information. See Table 89 for recommended minimum separation distances between portable and mobile communications equipment and the HeartStart MRx.

Immunity is defined in the standard as the ability of a system to perform without degradation in the presence of an electromagnetic disturbance. Degradation in ECG quality is a qualitative assessment which can be subjective.

Caution should, therefore, be taken in comparing immunity levels of different devices. The criteria used for degradation is not specified by the standard and may vary with the manufacturer.

## Guidance and Manufacturer’s Declaration

The HeartStart MRx is intended for use in the electromagnetic environment specified in the tables below. The customer or the user of the HeartStart MRx should assure that it is used in such an environment.

Table 85 Electromagnetic Emissions

Emissions Test	Compliance	Electromagnetic Environment - Guidance
RF emissions CISPR 11	Group 1	The HeartStart MRx uses RF energy only for its internal function. Therefore, its RF emissions are very low and not likely to cause interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The HeartStart MRx is suitable for use in all establishments, including domestic establishments or those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/flicker emissions IEC 61000-3-3	Complies	

Table 86 Electromagnetic Immunity - General

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
Electrostatic discharge (ESD) IEC 61000-4-2	$\pm 6$ kV contact $\pm 8$ kV air	$\pm 6$ kV contact $\pm 8$ kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	$\pm 2$ kV for power supply lines $\pm 1$ kV for input/output lines	$\pm 2$ kV for power supply lines $\pm 1$ kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	$\pm 1$ kV differential mode $\pm 2$ kV common mode	$\pm 1$ kV differential mode $\pm 2$ kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions, and voltage variations on power supply input lines IEC 61000-4-11	$< 5\% U_T$ ( $> 95\%$ dip in $U_T$ ) for 0,5 cycle  $40\% U_T$ ( $60\%$ dip in $U_T$ ) for 5 cycles  $70\% U_T$ ( $30\%$ dip in $U_T$ ) for 25 cycles  $< 5\% U_T$ ( $> 95\%$ dip in $U_T$ ) for 5 sec	$< 5\% U_T$ ( $> 95\%$ dip in $U_T$ ) for 0,5 cycle  $40\% U_T$ ( $60\%$ dip in $U_T$ ) for 5 cycles  $70\% U_T$ ( $30\%$ dip in $U_T$ ) for 25 cycles  $< 5\% U_T$ ( $> 95\%$ dip in $U_T$ ) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
$U_T$ is the AC mains voltage prior to application of the test level.			

Table 87 Electromagnetic Immunity - Life Supporting Functions

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the HeartStart MRx, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz outside ISM bands <sup>a</sup>	3 Vrms	Recommended Separation Distance $d = 1.2\sqrt{P}$
	10 Vrms 150 kHz to 80 MHz in ISM bands <sup>a</sup>	10 Vrms	Recommended Separation Distance $d = 1.2\sqrt{P}$

**Table 87 Electromagnetic Immunity - Life Supporting Functions (Continued)**



Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
Radiated RF IEC 61000-4-3	10 V/m 80 MHz to 2.5 GHz	10 V/m	$d = 1.2\sqrt{P}$ 80 MHz to 800 MHz  $d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz  where $P$ is the maximum output power rating of the transmitter in watts (W) according to the transmitter's specified output power and $d$ is the recommended separation distance in meters (m). <sup>b</sup>  Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, <sup>c</sup> should be less than the compliance level in each frequency range. <sup>d</sup>  Interference may occur in the vicinity of equipment marked with the following symbol:  
At 80 MHz and 800 MHz, the higher frequency range applies.			
These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			
<sup>a</sup> The ISM (industrial, scientific, and medical) bands between 150 kHz and 80 MHz are 6.765 MHz to 6.795 MHz; 13.553 MHz to 13.567 MHz and 26.957 MHz to 27.283 MHz; and 40.66 MHz to 40.70 MHz.			
<sup>b</sup> The compliance levels in the ISM frequency bands between 150 kHz and 80 MHz and in the frequency range 80 MHz to 2.5 GHz are intended to decrease the likelihood that mobile/portable communications equipment could cause interference if it is inadvertently brought into patient areas. For this reason, an additional factor of 10/3 is used in calculating the recommended separation distance for transmitters in these frequency ranges.			
<sup>c</sup> Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the HeartStart MRx is used exceeds the applicable RF compliance level above, the HeartStart MRx should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the HeartStart MRx.			
<sup>d</sup> Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.			

Table 88 Electromagnetic Immunity - Nonlife Supporting Functions

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the HeartStart MRx, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	<p><b>Recommended Separation Distance</b></p> $d = 1.2\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	$d = 1.2\sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = 2.3\sqrt{P} \quad 800 \text{ MHz to } 2.5 \text{ GHz}$ <p>where <math>P</math> is the maximum output power rating of the transmitter in watts (W) according to the transmitter's specified output power and <math>d</math> is the recommended separation distance in meters (m).</p> <p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,<sup>a</sup> should be less than the compliance level in each frequency range.<sup>b</sup></p> <p>Interference may occur in the vicinity of equipment marked with the following symbol:</p> 
At 80 MHz and 800 MHz, the higher frequency range applies.			
These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			
<p><sup>a</sup> Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the HeartStart MRx is used exceeds the applicable RF compliance level above, the HeartStart MRx should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the HeartStart MRx.</p> <p><sup>b</sup> Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.</p>			

## Recommended Separation Distances

The HeartStart MRx is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the HeartStart MRx can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the HeartStart MRx as recommended below, according to the maximum output power of the communications equipment.

**Table 89 Recommended Separation Distances**

Rated Maximum Output Power of Transmitter (W)	Separation Distance According to Frequency of Transmitter (m)	
	150 kHz to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	0.1 m	0.2 m
0.1	0.4 m	0.7 m
1	1.2 m	2.3 m
10	4 m	7 m
100	12 m	23 m

For transmitters rated at a maximum output power not listed above, the recommended separation distance  $d$  in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where  $P$  is the maximum output power rating of the transmitter in watts (W) according to the transmitter's manufacturer.

At 80 MHz and 800 MHz, the higher frequency range applies.

These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.



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