Introduction

You depend on your M3538A Lithium Ion Battery to provide the energy necessary to operate your HeartStart MRx monitor/defibrillator. To ensure that the battery is ready when you need it, you should understand how the battery functions and how to care for it properly. This application note describes the characteristics and care of lithium ion batteries.
Why Lithium Ion?

Lithium ion batteries store a large amount of energy in a small, lightweight package, so you can carry less and do more for a longer period of time. The integration of this technology into the M3538A Lithium Ion Battery results in a compact power source that contributes to the high performance of the HeartStart MRx while requiring minimal maintenance. The battery’s fuel gauge tells you how much longer you can treat your patients before changing batteries or needing to recharge. These excellent performance characteristics make lithium ion batteries ideally suited as a power source for the portable HeartStart MRx monitor/defibrillator.

M3538A Lithium Ion Characteristics

The M3538A Lithium Ion Battery was designed to provide the following characteristics:

- **Built-in fuel gauge** — The M3538A Lithium Ion Battery has intelligence that enables it to estimate the battery’s current state of charge. Convenient battery power indicators illuminate to show you the state of charge as a percentage of a fully charged battery.
- **Safe and reliable** — Redundant safety features in M3538A batteries protect the batteries and their users.
- **Quick charging** — Lithium ion batteries can quickly charge to their full capacity because they do not require an overnight trickle charge. The M3538A battery takes approximately 2 hours to reach 80% of its capacity and 3 hours to achieve a fully charged state from a fully discharged state.
- **Tolerant of Partial Charging** — Because lithium ion batteries are tolerant of partial charging, there is no effect on battery life when patient care requires you to suspend charging and use the battery before it is fully charged.
- **Low maintenance** — Lithium ion batteries do not need to be reconditioned like many other types of batteries. They only require charging and periodic calibration.
- **Low self-discharge rate** — The M3538A Lithium Ion Battery can sit on the shelf away from the HeartStart MRx for extended periods of time and still be ready to power the monitor/defibrillator when you need it. Spare batteries maintain their charge well. This makes lithium ion batteries well suited for use in settings where the monitor/defibrillator cannot be connected to a power source for charging between uses.
Battery Life

The life of an M3538A Lithium Ion battery depends on the frequency and duration of use and how well the battery is cared for. Philips recommends you replace your battery after two years of continuous service or when it fails battery capacity calibration as described in the HeartStart MRx Instructions for Use or shows other signs of wear as described in the “Battery Troubleshooting” table on page 5.

To optimize performance, a fully (or almost fully) discharged battery should be charged as soon as possible.

Battery Wear Symptoms

Physical wear of the battery housings and contacts may occur in environments where the battery experiences excessive vibration or frequent connections and disconnections (in and out of the HeartStart MRx). Physical aging and wear of battery housings and contacts may lead to intermittent power interrupt and reset to user default settings, that in turn may cause a delay in the ability to monitor or deliver therapy.

You can avoid intermittent power interrupt problems by keeping an additional battery installed in the second bay.

If your HeartStart MRx experiences intermittent power interrupt and reset, then your battery may be worn. Discontinue use of the worn battery and replace it with a new battery. If intermittent power interrupts and resets continue to occur after new battery replacement, please contact your Philips service representative.

Battery Care

Battery care begins when you receive a new battery and continues throughout the life of the battery. The table below lists battery care activities and when they should be performed:

### Battery Care

<table>
<thead>
<tr>
<th>Activity</th>
<th>When to Perform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform a visual inspection.</td>
<td>As part of the HeartStart MRx Operational Check.</td>
</tr>
<tr>
<td>Charge the battery.</td>
<td>Upon receipt, after use, or if a low battery state is indicated.</td>
</tr>
<tr>
<td>Perform a Calibration.</td>
<td>When the Calibration Recommended message appears after an Operational Check, or every six months, whichever comes first.</td>
</tr>
<tr>
<td>Store the battery in a state of charge in the range of 20% to 40%.</td>
<td>When not in use for an extended period of time.</td>
</tr>
</tbody>
</table>

**NOTE:** Refer to the HeartStart MRx Instructions for Use for details on how to perform battery care activities.
Charging

The M3538A Lithium Ion Battery should be charged in either the HeartStart MRx monitor/defibrillator or in a Philips-approved battery support system. From a fully discharged state with the HeartStart MRx turned off, it takes approximately 2 hours to reach an 80% state of charge and approximately 3 hours to reach a 100% state of charge. The battery will charge with the monitor turned on, but at a slower rate.

It is essential that you establish a charging schedule that enables you to:

- have a charged battery in the HeartStart MRx at all times
- have a charged spare battery with the HeartStart MRx or in the second bay of the HeartStart MRx
- charge stored batteries every 2 months and rotate batteries to distribute use evenly.

It is recommended that batteries be charged to their full capacity to give you the maximum monitoring and resuscitation time. However, partial charging will not harm the battery or affect battery life.

Charging and Operating Temperature

The charging and operational temperature range of the batteries is 0°C (32°F) and 45°C (113°F).

Storage

Use batteries regularly and rotate them to distribute use evenly. When storing batteries, make sure that the battery terminals do not come in contact with metallic objects and not subjected to wear and scratches in transport.

If batteries are stored for an extended period of time, they should be stored in a cool place, with a state of charge of 20% to 40%. Storing batteries in a cool place slows the aging process. Ideally, the batteries should be stored at a temperature of 15°C (60°F). The batteries should not be stored at a temperature outside the range of -20°C (-4°F) to 60°C (140°F).

Stored batteries should be partially charged to 20% or 40% of their capacity every 2 months. They should be charged to full capacity prior to use.

**NOTE:** Storing batteries at temperatures above 38°C (100°F) for extended periods of time could significantly reduce the batteries’ life expectancy.

Fuel Gauge Calibration

Although lithium ion batteries are known for their ability to retain their capability to store and deliver energy, capacity does diminish with usage and age. Periodically performing a calibration ensures that the fuel gauge of the battery will provide accurate estimates of the battery’s state of charge. In addition, calibration provides an estimate of the battery’s full charge capacity. Calibration may be performed using the HeartStart MRx or a Philips-approved battery support system. Calibration cannot be performed simultaneously with monitoring or therapy functions.

Avoid using batteries with calibration overdue. The fuel gauge of such a battery may indicate a wrong state of charge for the battery, which may lead to an unexpected shutdown in extreme cases.
HeartStart MRx Battery Care at a Glance

Battery Care

To take full advantage of your M3538A batteries:
- Have a charged battery with your HeartStart MRx (two batteries with M3536A) at all times.
- Rotate batteries to distribute use evenly. Partially charge stored batteries every 2 months if rotation is not practical. See the “Storage” section above.
- Charge batteries to their full capacity for maximum monitoring and resuscitation time. However, partial charging will not harm the battery.
- Perform a Calibration every 6 months or when the Calibration Recommended message appears after an Operational Check, whichever comes first.

Battery Diagnostics

Follow this table if you are concerned about your battery readiness:

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual signs of damage (check the terminal contacts, housing, and body)</td>
<td>Discard the battery</td>
</tr>
<tr>
<td>Calibration cannot complete in 24 hours</td>
<td></td>
</tr>
<tr>
<td>Calibration reports less than 80% capacity</td>
<td></td>
</tr>
<tr>
<td>Battery Temperature High INOP message appears</td>
<td></td>
</tr>
<tr>
<td>Battery fuel gauge LEDs are off or blinking</td>
<td>Recharge the battery</td>
</tr>
<tr>
<td>HeartStart MRx External Power Indicator is blinking</td>
<td>Discard the battery if the problem persists</td>
</tr>
<tr>
<td>HeartStart MRx shuts down or reboots when the Charge button is pressed</td>
<td></td>
</tr>
<tr>
<td>The Battery Charge indicator does not recognize the battery (the icon remains ☢️)</td>
<td></td>
</tr>
</tbody>
</table>

CAUTION: Lithium ion batteries store a large amount of energy in a small package. 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.