

iPAQ H3800 AND H3900 SERIES POCKET PC BATTERY

October 2002

Prepared By
Product Marketing
iPAQ Mobile
Solutions

HP/Compaq
Computer
Corporation

iPAQ H3800 and H3900 Series Pocket PC Battery White Paper

Topics include:

- iPAQ Pocket PC Battery Terminology
- Battery Design
- Battery Usage
- Power Management on Devices
- General Usage Tables
- Accessories
- Frequently Asked Questions

Executive Summary

Abstract: This Battery White Paper is designed to inform customers about the battery technology used in the iPAQ Pocket PC H3800 and H3900 Series.

This document provides information on how to best configure the iPAQ Pocket PC H3800 and H3900 Series to optimize run time, how various accessories use battery power, and how to charge your Pocket PC.

iPAQ Pocket PC Battery Terminology

Backlight – Also called Front Light. This is a Cold Cathode Fluorescent Lamp (CCFL) used to light the display. The backlight is one of the highest consumers of battery power. The brighter the light, the more power is consumed.

Backup Battery – The iPAQ Pocket PC does not contain a separate backup battery. A portion of the internal main battery is reserved for back-up purposes. When the Pocket PC is running on the back-up portion of the main battery, it is in Battery Reserve.

Battery Capacity – The amount of available battery storage. As lithium ion batteries get older, with use, they lose capacity. The battery is designed to retain a minimum of 80% of its original capacity after 300 complete discharge and charge cycles.

Battery Disconnect – This is the state where the battery is prevented from supplying power to the Pocket PC. Pressing the power button will not turn on the device. The Pocket PC ships from the factory in this mode. Connecting the Pocket PC to AC power or pressing the reset switch will activate a battery that has been placed in battery disconnect mode. A Full Reset is accomplished by placing the Pocket PC in this mode, then re-activating the battery. To prevent over-discharge to the battery, the Pocket PC will protect the battery by entering battery disconnect mode when the battery reserve has been depleted.

COMPAQ

Document No. 308402-001

Battery Reserve – Also called Memory Retention Time. The battery reserve acts as a backup battery for the Pocket PC. It also determines the length of time that the unit will retain user data and programs in RAM after the main charge is depleted. While in Battery Reserve mode, the power button cannot be used to turn on the unit. This period starts after the final warning of low power and ends when the battery disconnects via software to prevent over-discharge. It is important to connect the Pocket PC to AC power and recharge the battery before the battery disconnects to prevent loss of user data and programs.

Full Reset – Also called Hard Reset or Cold Boot. This is accomplished by placing the battery into Battery Disconnect mode, then re-activating the battery. Disconnect the battery by pressing and holding application buttons 1 and 4 simultaneously while pressing the reset switch for approximately 5 seconds. A full reset will clear both running programs and erase user data and programs in RAM. Information such as contacts and appointments are stored permanently in non-volatile memory or Permanent PIM. A full reset will return the Pocket PC to the factory default settings but will not erase the contents of the File Store or a backup of contacts or appointments from Permanent PIM.



Learn Cycle – Also called Battery Calibration. This is a routine that can start when the battery has completely discharged to the point of disconnecting the battery. As the battery is charged, parameters that are used to monitor or report battery status are reset. The Learn Cycle routine cannot be started in any other manner.

Normal Reset – Also called Soft Reset or Warm Boot. This is accomplished by pressing the reset switch located on the bottom of the unit for 2 seconds with the stylus. A normal reset will clear any running programs, but will not erase user data and programs in RAM.



RAM – Also called Memory. Random-access memory (RAM) is a type of memory that is written to and erased many times. The user data in RAM can be lost if battery or AC power is no longer available. RAM in the unit is used for two purposes – storing user data and programs, and running programs. The allocation of memory for each purpose is managed automatically. This can be viewed by tapping → **Start** → **Settings** → **System** → **Memory**.

ROM - Read-only Memory (ROM) is a type of memory that is written to once and cannot be overwritten or changed without special utilities. Contents in ROM are not lost when power is no longer applied. The operating system and other factory default programs are located in ROM.

Run Time – Also called Battery Life. This is the length of time the device is actively displaying data or performing a function on battery power.

Shelf Life – This is the amount of time that a battery can stay in storage without diminishing its capacity to hold a charge.

Standby – Also called Suspend or Off. This is the device state often referred to as “powered off.” The unit is not being used, but battery power is still being consumed to keep user data and programs in RAM.

Battery Design

Battery Selection

One of the most important decisions in the design of a handheld device is the battery selection. Trade offs must be made between battery technology, run time, battery life, weight, size and other factors. All of these factors are interdependent and must be considered at the same time. In a perfect world, a battery would have no weight, consume no volume, and have endless capacity. However, it is obvious that this is not possible. Over the past few years, new technology which offers many advantages for use in handheld devices have become available.

Lithium Polymer Technology

The battery used in the H3800 and H3900 Series iPAQ Pocket PCs is a 1400 mAH internal lithium polymer battery. This design combines a battery with the highest energy capacity in a space-saving package. Lithium Polymer has many advantages over other battery technologies, including no memory that can diminish capacity in other technologies. It is ideal for devices like Pocket PCs because it is tolerant of conditions in which it is constantly being re-charged or “topped off.”

Like all batteries, lithium polymer batteries lose capacity over time. The batteries selected for the iPAQ H3800 and H3900 Series product is designed to have at least 80% of their original capacity after 300 full charge/discharge cycles. During normal usage, many users will not completely discharge the battery before it is recharged. A partial charge/discharge cycle is not harmful and only in part affects the life of the battery. For example, the user may remove the device from the cradle and check the time for the next meeting. He/she can carry the device for a few hours and return to the office where the device is reinstalled into the cradle. At this time, only a small portion of the battery capacity will have been consumed. The device can be connected to AC Power and the unit will recharge. With this kind of scenario, the user can expect several years of battery life.

Coin-cell Design Disadvantages

There is another type of battery called a coin cell or dual-battery design. This battery design is not used in the H3800 or H3900 Series iPAQ Pocket PCs. Typically, these are non-rechargeable lithium ion cells that maintain the RAM state for a specific period of time when the main, rechargeable cell, becomes discharged. These systems have certain disadvantages versus the single battery design.

- Dual-battery design uses a coin cell battery to function as the backup battery. After the coin cell is used to maintain the RAM state for a period, it is discharged by a certain amount. This results in the backup time being less than that of a new cell. The coin cell battery must be replaced if used to maintain the system for any appreciable time period. If a user does not monitor their backup battery, they risk having no backup reserve power when they need it. With a single-battery design, the backup reserve is recharged each time the user cradles the unit or attaches it to an AC Adapter.
- Dual-battery design (coin cell) is intrinsically less efficient than a single-battery design because of the need for more circuitry.

Battery Usage

Run Time

The Pocket PC may be used for short periods of time or it can be used continuously. In either case, the run time is the total time of active use. The run time can vary greatly with many factors and configurations. For example, using High Bright setting will affect run time dramatically. High Bright is the default backlight setting when the unit is docked and on AC power, however, it should be used infrequently if the user wants to extend run time while using battery power.

If the need is to increase capacity, the trade off must be to increase size and weight. It is obvious that there are limits to size and weight so with boundaries set on those factors, run time is only affected by power consumption. In the case of the iPAQ Pocket PC H3800 and H3900 Series product, the run time can be as long as 14 hours in the Power Save or Backlight Off mode. As stated earlier, run time is affected by many factors; therefore, industry standard methods are used to define and measure run time. HP has chosen to support a standard test suggested by Microsoft for Pocket PC certification. The test generates activity every few seconds to emulate user input.

Shelf Life

When an iPAQ Pocket PC is shipped from the factory the battery is disconnected so that the Pocket PC can stay longer on a retailer's shelf without loss of capacity. After the user receives the unit and begins to use it, the shelf life is not in effect and the user will not experience shelf life unless the battery is disconnected again. The shelf life of the H3800 and H3900 Series Pocket PC for a fully charged disconnected battery is approximately 4 years. If the battery is completely discharged when disconnected, the shelf life is approximately 1 year.

Battery Status

The battery status charge indicator in the power applet of the unit is displaying the percentage of the battery charge remaining based on current and temperature (similar to the gas gauge on your car). The battery status reading is more accurate than the battery voltage reading because the battery voltage curve changes with battery usage temperature and age. Utilizing current and temperature allows the power applet to provide a more detailed and accurate battery status.

Storage of the iPAQ Pocket PC

The H3800 and H3900 will automatically disconnect the battery to prevent over discharge. After the battery has disconnected, the shelf life is approximately 1 year.

Battery Reserve

Data will be maintained for approximately 72 hours while in battery reserve.

LED Indicators

The LED located next to the power button indicates charging and charge status by using the following signal indicators:

- Flashing amber light – battery is charging
- Solid amber light– battery is charged

Battery Charging

From the point where the iPAQ Pocket PC enters Battery Reserve mode, it takes approximately 3 hours to fully charge the battery.

Constantly discharging and recharging the iPAQ Pocket PC or leaving it in the charger does not overcharge or damage the battery.

Once the battery reaches a full charge and the LED changes to solid amber, the charger actually stops charging the battery. When the battery drains to a certain level, charging will resume and “top off” the battery and stop again.

POWER MANAGEMENT ON DEVICE

iPAQ Pocket PCs have several power management related settings that can be adjusted by the user to customize a battery-powered profile.

Backlight Brightness Level

When the iPAQ Pocket PC is on, the backlight brightness has the most impact on battery charge of all the power management settings.

- Highest brightness level delivers the shortest battery charge.
- Medium Bright is the default brightness level.
- Lowest brightness level, also called Power Save or Backlight Off mode (no backlight, reflective screen only) delivers the longest battery charge.

Activating the automatic feature enables the iPAQ Pocket PC to monitor the ambient light in the usage location and adjusts the backlight brightness to match the environment. This should improve battery run time, if the use of the iPAQ Pocket PC is in a brightly lit area for a significant amount of time.

On iPAQ Pocket PCs, the Backlight Brightness Level controls can be accessed from the Today screen by tapping → **Start** → **Settings** → **System** → **Backlight** → **Brightness**.

Note: The brightness level will dim to Medium at the critical battery power warning.

Audio Settings

Audio volume settings have a significant impact on battery performance. The audio settings can be accessed from the **Today** screen by tapping → **Start** → **Settings** → **Personal** → **Sounds & Notifications** → **Notifications**. The higher the volume level is set, the greater the impact will be on the battery.

GENERAL USAGE TABLES

H3800 Series Battery

The iPAQ Pocket PC has been tested for constant use battery charge using the industry standard test program for Pocket PCs. This test is part of the suite of tests required for Pocket PC certification. The constant use test allows for worse case battery charge to be determined for each iPAQ power management settings group. The table provides average run times using different backlight setting with and without different expansion packs using CF and PCMCIA cards as noted below in the table.

H3800 Series Battery					
Backlight Settings	iPAQ (unit only)	iPAQ with PC Card Expansion Pack	iPAQ with PC Card Expansion Pack Plus	iPAQ with Dual PC Card Expansion Pack Plus	iPAQ with CF PC Card Expansion Pack Plus
High	4:21	4:02	2:41	4:02	4:41
Medium	5:41	5:21	3:02	4:21	5:22
Low	8:42	6:22	5:51	6:21	6:22
Off Mode	13.48				

Note:

- Depending on the device purchased usage time can vary from device to device.
- WL110 PC cards were used for the PC Card Expansion Pack and PC Card Expansion Pack Plus tests. Linksys CF modems were used for the CF Card Expansion Pack tests.
- All iPAQ Pocket PCs and expansion packs were fully charged at the start of the test. The Expansion Pack Plus had 920 mAH batteries installed.
- These tests were conducted for 72 hours at room temperatures of approximately 25C degrees.
- The Audio volume setting will affect run time, the higher the volume the shorter the run time.

H3900 Series Battery

The table provides average run times using different backlight setting with and without different expansion packs as noted below in the table.

H3900 Series Battery						
Backlight Settings	iPAQ (unit only)	iPAQ with CF Card Expansion Pack	iPAQ with PC Card Expansion Pack	iPAQ with PC Card Expansion Pack Plus	iPAQ with Dual PC Card Expansion Pack Plus	iPAQ with CF PC Card Expansion Pack Plus
High	4:28	4:21	6:57	7:11	7:50	7:20
Medium	6:42	6:39	10:49	11:00	13:38	11:11
Low	12:37	12:40	19:38	20:04	26:59	20:17
Off Mode	13:42	13:45	22:18	21:52	30:26	22:41

Note:

- Depending on the device purchased usage time can vary from device to device.
- All iPAQ Pocket PCs and expansion packs were fully charged at the start of the test. The Expansion Pack Plus had 920 mAH batteries installed.
- These tests were conducted for 72 hours at room temperatures of approximately 25C degrees.
- The Audio volume setting will affect run time, the higher the volume the shorter the run time.

ACCESSORIES

CF and PC Expansion Pack Plus Battery Information

The CF Expansion Pack Plus and the PC Expansion Pack Plus each have removable batteries. They each support a 920mAH or an 1840mAH battery. These are lithium ion polymer batteries. The battery acts as an extended battery for the Pocket PC. This means that if the battery has sufficient charge it will provide power to the Pocket PC rather than the using its internal battery. When the external battery no longer has sufficient power, then the Pocket PC will switch to its main battery. The extended battery will always drain first, except on the PC Expansion Pack Plus with PC card inserted.

Extended Battery CF and PC Difference

The CF Expansion Pack external battery always acts as a power source for the iPAQ Pocket PC, regardless of whether there is a CF card being used. However, the PC Expansion Pack battery only acts as a power source for the Pocket PC when there is no PC card being used. Whenever a PC card is inserted in the Expansion Pack, then the external battery supplies power to the PC card slot and not to the Pocket PC. Also, the extended battery is optional on the CF Expansion Pack but is required on the PC Expansion Pack.

Trickle Charge

Both expansion packs will also trickle charge the main unit battery from the external battery. This occurs only when the external battery voltage is higher than the main unit battery. The trickle charge current can be from 0 to 200ma, depending on the voltage difference. The higher the difference, the greater the current. The trickle charge and the battery voltages are the same. Therefore, if the main battery is very low and the external battery is fully charged, then the external battery will trickle charge the main battery until they have the same voltage. The trickle charge occurs with unit turned on or off. If the main unit battery is near 0% charge and the external battery is near 100% charge, after several hours with the Pocket PC off, but attached to the Expansion Pack, the main battery will be up to 30%-40% charge and the external battery will be down to 50% to 60%. Since the capacities are not the same, both batteries will not reach 50%. It will be different on the iPAQ Pocket PC H3600/H3700 models versus the H3800 since their main batteries also have different capacities. Also, note the PC Card Expansion Pack does not trickle charge when the unit is on and a PC card is inserted.

Charging

The batteries charge in approximately 2 hours on the Pocket PC. The charge current is about 500ma for both. However, if the unit is also charging its battery and the unit is on, then the charge current is reduced to 100ma on the PC Expansion Pack Plus 300ma on the CF Expansion Pack Plus. The standalone battery charger also uses 500ma charge current except on the 1840mAH battery where 1000ma is used. It will charge either battery in about 2 hours. It can charge two batteries in about 2 hours unless both are 1840mAH batteries. If both batteries are 1840mAH, one will charge in about 2 hours and the other in about 3 hours.

Frequently Asked Questions

How do I disconnect a battery?

To disconnect the battery on the iPAQ Pocket PC H3800 and H3900, press and hold down the 2 outer buttons on either side of the navigation button, and press and hold the reset switch with the stylus for about 5 seconds. The screen will fade if this is done properly. (See Reset definition).

What is the run time of the Pocket PC and how was it determined?

The run time of the Pocket PC is up to 14 hours of constant use in Power Save or Backlight OFF mode. The life is determined using a standard test required by Microsoft for Pocket PC certification.

Actual run time will vary considerably depending on the backlight settings, settings of alarms and warnings, use of the Media Player, or expansion pack usage.

For example, using maximum brightness at all times will affect run time dramatically. Maximum brightness is the default backlight setting when the unit is docked and using AC power, however, it should be used infrequently if you want to extend run time while using battery power. This setting should not be used for long periods of time while traveling to conserve battery power. Enabling the automatic feature of the Brightness Setting will match the backlight to the surrounding ambient light.

How does the battery power management scenario work?

The battery is a lithium ion polymer cell with 1400 mAH capacity. The battery fully charges in approximately 4 hours.

If the unit is connected to AC power, within the 72-hour window, the unit will turn on, then perform a normal reset. The data in RAM will be maintained.

While in use, the battery has 4 warning conditions: Stages 1 to 3 (Low and Critical). (See: What are Battery Discharge Scenarios?)

What Power Management options are available to improve battery life?

Screen Brightness settings have the most impact on battery life. This means that you should choose the brightness level that matches your needs, using the High Bright mode only while connected to AC power.

Tips to lengthen battery life:

Disable audio if this feature is not required. Go to **Start** → **Settings** → **Personal** → **Sounds & Notifications** and disable all sound boxes and put the system volume to Silent. Under **Start** → **Settings** → **Personal** → **Sounds & Notifications**, go to the **Notifications** and disable the **Flash Light** box. This means that there will not be a LED warning light flashing at each event.

What Power Management options are available to improve battery life? (continued)

If it is necessary to keep the setting enabled, set the time at 5 minutes. Under **Start** → **Settings** → **System** → **Backlight** set the backlight to turn off after 1 minute or less while on battery power and this will enable the backlight to turn on when the screen is tapped.

If using Media Player exclusively, use the programmable button option to turn off the screen while listening to MP3 files.

How long will data be retained after the battery is drained to the point at which the device no longer can be powered on?

You will have 72 hours of data retention time. You should recharge your battery as soon as possible after receiving the low battery warning to prevent data loss.

Note: The battery reserve is set by default to 72 hours, but can be adjusted (H3900 Series only) from 25 to 100 hours by the user.

After a critical state battery power down, what happens when you connect to AC power?

The unit will turn on and the battery will start being charged. The amber LED should start to flash.

What are Battery Discharge Scenarios?

There are 3 main stages:

Stage 1: When the unit reaches a low charge (40%), a low battery-warning message will appear periodically. The system will continue to function normally.

Stage 2: As the battery charge reduces (20%), the backlight is unable to be set higher than Medium Bright. The audio playback will be halted and an error message will be displayed. Power to CF and SD card is shutoff. This is done to prevent data loss due to high current spikes.

Stage 3: When the unit reaches a critical charge level (0%), the power button will no longer function. The Pocket PC is now in the battery reserve mode.

What are the backup options?

Active Sync has a back-up feature that will take a snapshot of the RAM portion of the device and give the user the ability to restore that image. It is located in the Tools portion of ActiveSync.

A user can back up to a storage card using an expansion pack. This option allows the backup image to be stored separately from the Pocket PC's RAM in the event the unit loses all data.

What are the backup options? (continued)

The Pocket PC itself also has a Contacts Backup feature. When enabled, the contacts are saved to a small area of the flash ROM. In the event that all power is drained and you are not able to restore power while away from your office, this feature would save your important phone numbers to flash ROM until you return to your office and recharge the device.

What are other battery concerns that a user needs to be made aware of?

- The Pocket PC wakes up at midnight and turns the unit on. This action resets the Calendar and Task reminders. The unit will then power down according to the settings in your device. By using the Settings and Power Management features, this will shut the unit down quickly and enable longer battery life.
- When the Pocket PC is docked in the cradle, the backlight settings default to High Bright. When undocked, the unit maintains that High Bright setting and does not return to the user defined backlight setting. The user must reset the device to the previous setting or cycle power on the Pocket PC.

What will lengthen battery life?

- Do not leave your WLAN card in the unit at all times.
- Keep the Pocket PC plugged in to AC power whenever possible.
- Charge the iPAQ Pocket PC in the cradle overnight.

What about long term storage of the battery?

- It is recommended that you fully charge the battery prior to long-term storage. To place the battery in storage, hold down the two outer application buttons and press the normal reset button for 5 seconds. The screen will fade and the unit will now be in ship mode. All data on the Pocket PC will be erased except any data that is stored in iPAQ File Store. Data backed up in Permanent PIM will still be intact. You must apply AC power to re-activate the battery. (See Battery Usage definition.)

What has the greatest impact on battery life?

- Backlight
- Playing games
- CF card with or without battery
- Micro drive

To achieve maximum hours of battery life what should I do?

- The audio must be OFF and the brightness setting on Power Save or Backlight OFF mode. Depending on the applications you are using battery consumption may vary.

What type of warranty do I have on my battery?

- You have a 1 year warranty on your battery.

What if my warranty has run out and my battery stops working, what should I do?

- It is recommended that you return your unit to HP, where it will be serviced for a charge.

Can I replace my battery in my iPAQ Pocket PC H3800 and H3900 myself?

- No, this is a service event. See the Warranty document that shipped with your Pocket PC.

Will temperature affect the battery?

- Warmer temperature will enhance battery capacity.
- Colder temperature may decrease battery capacity.

Can you use a hand-powered battery pump to re-power the battery?

- This method to re-power the battery has been used but it is not an authorized solution from HP.

Is there a worldwide battery exchange service?

- At this time there is not a formal battery exchange service program.

How frequently can you recharge the battery?

- Your battery can be recharged at any time. The frequency does not have any affect on the Pocket PC. Frequent recharging improves the battery condition.

Will the battery become damaged by charging it before the battery has completely discharged?

It is recommended that the Pocket PC remain connected to AC power when not in use. Being connected to AC power for an extensive period of time will not damage the battery. The Pocket PC operates with a lithium ion battery that does not retain a memory.

If my battery has charged over night and still will not power up by the battery power, what should I do?

To fix this problem, the unit will need to be repaired. If in the United States, you can call 1-800-652-6672, options 2,2,1, and set up a repair with Technical Support. They can have the unit picked up and delivered to the repair center. Once it is repaired, it will be returned to you. If you are not in the United States, contact the HP office in your country. You can find the phone number at:

http://www.compaq.com/corporate/overview/world_offices.html

Can the battery disconnect and how?

Disconnect occurs in two ways.

The user can disconnect the battery manually (in order to store the unit or to perform a Full Reset.)

- The unit will automatically go to disconnect-state at the end of the battery reserve period.
- If the battery is fully charged, and the device is not used, the battery will disconnect after approximately 29 days and 4 hours of nonuse. If the battery is discharged, the battery would disconnect after 72 hours (reserve time) or 25 to 100 hours (reserve time on 3900 Series).