



HP Photosmart Digital Cameras Technical Backgrounder

HP Photosmart Digital Camera Batteries



Battery Usage in HP Digital Cameras

There are many different types of batteries used in digital cameras today and battery performance is a key component of camera performance and evaluation. Unfortunately, measuring battery performance for cameras can be both time consuming and difficult, and often the results of that testing do not reflect what a typical photographer may see. This technical backgrounder describes how different battery types work in a digital camera and how to best measure battery performance. Both AA batteries and non-AA battery packs are discussed, but remember, cameras will tend to use AA batteries or a battery pack, not both.

HP's Photosmart R-series digital cameras come with an R07 rechargeable lithium ion battery. Some R-series cameras also support a Duracell CP1 disposable¹ lithium battery. All other current HP Photosmart digital cameras use two AA size batteries with the exception of the HP Photosmart 945 which uses four. Most HP Photosmart digital cameras support charging of rechargeable batteries in the camera and automatic battery chemistry detection. In other words, if you have rechargeable NiMH batteries in your camera and you connect it to an HP camera dock (optional) or plug in the AC adapter, the camera batteries will recharge. If you have non-rechargeable batteries in your HP Photosmart digital camera – the camera will automatically detect that and will not attempt to charge the batteries.

Trends in Digital Camera Batteries

Expectations and usage of batteries in digital cameras continues to evolve with competing goals and factors preventing a clear direction regarding battery life. On one hand, as cameras get more efficient and CCD's get smaller, battery life – the number of photos you can take with a set of batteries – increases. On the other hand, larger LCD displays and the fact that more and more cameras have no optical viewfinder which requires the LCD display to be on more of the time may drive battery life toward fewer photos per set of batteries.

¹ Always recycle or dispose of batteries appropriately.

In general, during any given year, you can generally expect more expensive cameras to use more power, have larger batteries, and drain them faster than lower cost models. This is because of larger sensors, faster processors and more features, such as optical zoom, in higher end cameras. You can also expect the power usage of a camera with a given feature set to decrease from one year to the next because of improvements in the electronics and power management. For example, a four AA battery camera made in 2000 might have about the same battery life as an identical two AA camera made in 2002.

Design and usage factors that impact battery life

Battery life in digital cameras can be impacted by several factors:

1. Selection of the wrong battery chemistry for the camera. Simply using the wrong kind of battery in the camera.
2. Use model – using the camera in a way that was not anticipated by the designer.
3. Using a power-intensive use model. Often ‘battery testing procedures’ use a highly power-intensive model to accelerate the testing process. These results may not represent actual camera performance in the hands of an average photographer.
4. Poor camera design.

In any case, when discussing battery performance, it is most important to direct the photographer to a battery chemistry and use model that will work for them. Rarely does a ‘one size fits all’ measurement really work.

Understanding the digital camera use model and how it impacts battery life.

The way a digital camera is used is at least as important as battery chemistry selection in influencing battery life. Since digital cameras have many different user-controlled modes such as live preview, playback, capture and video as well as other user-controlled features like flash and zoom, the user has an immense amount of control over battery life.

The highest power modes in any digital camera will be video and live view. Live view is using the LCD to frame the photo rather than the optical view finder. Since more and more digital cameras have no optical view finder – use of live view is increasing.

Live view is considerably more power intensive than playback mode (reviewing images already taken) since in live view not only is the LCD on – but the CCD and image processing hardware are also operating. Thus, heavy users of these modes will see the shortest battery life. This is exacerbated by the fact that some batteries, like alkaline, don’t perform well under high power loads. In playback mode, when you are reviewing images stored on the camera, the CCD and much of the image processing hardware can be turned off.

Other significant power consumers are the strobe (flash), zoom motor and the image LCD display. Higher performance zoom lenses (more or faster zoom capability) take more power than slower and smaller lenses. Larger flash units take more power. The photographer who understands the power consumption of these functions, can better manage battery life.

Typical Energy consumed by various operations in terms of shots

(1 shot = 1 no live view/zoom/strobe picture)

- Turn on camera (extend lens) = 0.5 shots
- Zoom (full) = 0.5 shots
- Strobe (full) = 0.5 shots
- Live Preview (5 seconds) = 0.5-1.0 shots
- Video (5 seconds) = 1.5-2 shots (think of a 60 second clip as 24 shots!!)
- Instant Review (2 seconds) = 0.1 shots

Reading the battery gauge

Another point worth mentioning is that batteries that read 'empty' on the battery gauge are not necessarily 'dead' batteries. If the user is doing something very power-intensive, like continuous video capture or live view, and the camera shuts down, that indicates that the battery voltage has dropped too much to continue operating in that high power mode. Often sufficient battery power is left to operate the camera for a significant period in lower power modes like reviewing images. High power modes may become available again if the batteries are allowed to recover for a while with the camera turned off. Thus, it is generally recommend that users should use the camera until it shuts itself down two or three times before deciding that the batteries are absolutely dead, especially if they are in a cold environment or have continuously been in a high power mode like live preview or video when the first shutdown occurs.

Note: For this reason, when measuring battery life, continuous shooting till first "shut down" may not give a good indication of actual camera performance by a photographer.

Some cameras may contain a special component called an ultra capacitor which extends battery life by supplying current during peak demand times. Batteries tend to operate better at lower, more constant, current loads and by slowly charging the ultra capacitor and then using the ultra capacitor to provide the peak current loads, battery life will be extended. However, if the ultra capacitor is not allowed to charge, it's impact is eliminated. If the camera is immediately placed in a high use mode after power up – and never allowed to 'rest' – the ultra capacitor will not charge.

What's the difference between all the available battery chemistries?

AA batteries are available in four basic varieties: Alkaline, Nickel-Metal Hydride (NiMH), Nickel-Cadmium (NiCad), and Photo Lithium (Li-FeS₂). Alkaline and photo lithium are non-rechargeable while NiMH and NiCad are rechargeable. Non-AA battery packs are usually NiMH, Lithium Ion (Lilon), both rechargeable, or Lithium Manganese Dioxide (LiMnO₂), which is not rechargeable.

Non-Rechargeable vs. Rechargeable:

While rechargeable batteries are generally desirable from an environmental standpoint, they may not be right for some users. All batteries self-discharge even when not being used – whether in a camera or on the shelf. Rechargeable batteries have faster self discharge rates than non-rechargeable batteries. While they can be recharged and work perfectly again, they will frequently be low or dead if the user picks up the device after several weeks of inactivity with no charging taking place. For infrequent users, the sort who will take a camera on a vacation and then put it in a desk drawer until the next holiday, this may be unacceptable. Every time they pick up the camera, they need to recharge it before it can be used. The problem of self-discharge can also be very confusing to users who think that they've only gotten a few shots on a charge, not realizing that the fact that the camera sat for a few weeks has batteries that are already depleted.

Using a camera dock – available for most HP Photosmart digital cameras, is a good solution to the above problem. If you leave the camera in the dock – the battery charge is maintained. HP Photosmart R-series digital camera docks include a charging bay for a second battery – which means not only is your camera battery charged – so is the spare supplied with the dock.

Non-rechargeable batteries generally have very long shelf lives and extremely slow self-discharge rates. This makes them ideal for infrequent users because the camera remains charged and ready for use over weeks and months of non-use. In addition, they are available fully charged in stores all over the world which makes them a convenient choice for when rechargeable batteries go dead and you have no time to recharge.

Battery chemistry and suitability for use.

Photo Lithium Batteries (Li-FeS₂) (non-rechargeable):

Photo lithium batteries work very well for digital cameras. They yield the longest battery life of any chemistry, surpassing NiMH by 50-100% and surpassing alkaline by 100-500%, depending on the load. The higher the load, the better this battery will perform relative to alkaline. This is important: While they are more expensive per battery than alkaline batteries, their additional energy capacity makes them cost the same or less per shot than alkaline batteries.

HP recommends these batteries as a non-rechargeable alternative to all users, especially those who like to use high power modes or those who find a rechargeable battery inconvenient.

Nickel-Metal Hydride Batteries (NiMH) (rechargeable):

NiMH batteries are the rechargeable battery supported in HP cameras that use AA size batteries. NiMH batteries are more environmentally responsible than NiCad and have no memory effect. NiMH batteries are the lowest overall cost for users that take a lot of pictures (more than 30 per month) or use a lot of high power features.

The main disadvantage to NiMH batteries is their fast self-discharge rate of 1-2% per day. Sometimes this leads to a confused user who doesn't understand why their batteries went dead when they haven't been taking pictures. When a user asks why they only got a few shots on NiMH batteries, always ask what time period those few shots were taken over. If they say "a month or two," self-discharge is likely the cause. HP cameras that support in-camera charging will eliminate this problem if the camera is stored in the dock or plugged in. If the user leaves the camera with NiMH batteries in a closet or desk drawer when not in use, self discharge is inevitable.

Note: An additional point of confusion is that many NiMH batteries need to be charged and discharged a few times when brand new to achieve their full capacity. Many users charge them once and are very disappointed with their battery life, not realizing that their capacity may double after a few more charging cycles.

Also remember that rechargeable batteries don't last forever. If a user sees a decrease in battery life either quickly or slowly over time, a worn-out battery may be the cause. Storing or charging the batteries in hot conditions or getting the battery extremely hot (left on the dashboard of a car in the summer, for example) can shorten battery life.

Nickel Cadmium Batteries (NiCad) (rechargeable):

NiCad batteries are not supported in HP Photosmart digital cameras and not recommended. NiCad's suffer from two problems. First, cadmium is an environmental problem. If NiCad batteries are used, they must be appropriately recycled. Second, NiCad batteries suffer from 'memory effects' if not managed very carefully. A memory effect occurs if a NiCad battery is recharged without being fully discharged first. If this is done repeatedly, the NiCad 'remembers' the partially discharged state as its fully discharged state and will rapidly lose life. If you use NiCad's, they should be fully discharged (used till dead) before each charge cycle.

Lithium Ion Battery Packs – also called prismatic Lithium Ion (rechargeable)

You may be familiar with lithium ion batteries as the latest-and-greatest rechargeable battery technology. Lilon batteries do provide about 15% higher capacity than NiMH batteries, but the two main advantages of Lithium ion batteries are slower self-discharge rate and a thin form factors. Lithium ion batteries self-discharge at a rate of around 5-10% a **month** (as opposed to NiMH at 1-2% per **day**), so they stay charged 2-5 times longer when sitting around in an unused state. This helps quite a bit with ease of use and user perception of battery life. In addition, they are commonly made in very thin, rectangular form factors. These reasons - size and discharge - are the primary reasons HP chose to use this battery in the Photosmart R707 camera.

Lithium Manganese Dioxide (disposable)

Because HP also recognizes the value of a widely available disposable battery for cameras, some HP cameras that take Lilon cells can also use Lithium Manganese Dioxide cell – typically available wherever camera batteries are sold. The LiMnO₂ cell provides the power a digital

camera needs in a small disposable package with long shelf life. This allows photographers to carry a spare battery that does not self-discharge over time, so it's always ready if your rechargeable battery is dead. In addition, it provides a safety net for customers who have forgotten to recharge, or perhaps have forgotten to bring an AC adapter or charger along while traveling.

What battery should I use for the best performance?

This table below summarizes some of the most common questions related to battery selection

Form Factor	Battery Type				
	AA Alkaline	AA NiMH	AA LiFeS ₂	Pack Li Ion	Pack LiMnO ₂
P Poor. Unacceptable.					
F Fair. Will work, but...					
G Good. Use this!					
Type of Use (for average camera)	Alkaline	NiMH	LiFeS₂	Li Ion	LiMnO₂
Video, Live Preview on LCD	P	G	G	G	F
Heavy Strobe Use, Frequent Pictures	P	G	G	G	F
Infrequent Use (no dock)	F	F	G	F	G
Infrequent Use (with dock)	F	G	G	G	G
Photographer Wants to Recharge	P	G	P	G	P
Low Temperature/Winter Use	P	F	G	F	G
Most Economical (over 30 pix/month)	P	G	F	G	F
Most Economical (under 30 pix/month)	F	F	G	G	G
Longest Overall Battery Life	P	F	G	G	G
4 Battery Camera	F	G	G	N/A	N/A
2 Battery Camera	P	G	G	N/A	N/A

How does one test battery life in digital cameras?

Battery life in digital cameras is difficult to measure. Different modes, such as live preview and playback, consume vastly different amounts of power and different people use their cameras in very different ways. Different battery chemistries and age yield very different results and the results produced by any one battery chemistry can be highly dependent on use model simulated during the test. Even the battery charger used for charging rechargeable batteries can have a surprisingly large effect on test results.

While it is never possible to make battery life testing exactly like real use, the key to good testing is to make it as representative of real use as possible given time, money, and other testing limitations. Here are some rules of thumb that will make testing as meaningful and repeatable as possible and some recommendations and things to consider when constructing a battery life test:

- Test with comparable batteries, preferably the same set. If two cameras don't accept the same battery form factor, use the closest two choices. For example, if one camera takes AAs and another takes a Li ion pack, the comparison should be made with the AA camera running on NiMH because that is the most realistic comparison to Li ion. Another good comparison is LiFeS₂ (photo lithium AAs) to LiMnO₂ (CR-V3s). Alkaline should only be compared to alkaline.
- Use batteries in excellent condition. This means using rechargeable batteries that have not been used for more than 3 months and are not showing any signs of degradation, such as becoming warmer than normal during charging. If they are NiMH, they **must be conditioned** by charging and discharging at least 4-5 times before being put into service as a testing set.
- Use freshly charged batteries. All rechargeable batteries self-discharge over time even when they are not used and, since most chargers don't top off batteries periodically, they will self-discharge even if they are sitting in a charger. Batteries should be placed in a charger and undergo a full charge cycle not more than one day before the beginning of testing.
- When replacing battery testing sets, try to stay with the same brand and model if at all possible. Even within a given chemistry at a given rating, performance may vary as much as 10-20% with battery brand and model.
- Use the same charger as much as possible. There are substantial differences in chargers. Some don't charge batteries adequately or consistently. Choose a high quality charger that has charge termination. All Li ion chargers should have this, but some NiMH chargers do not. Be wary of old-style slow chargers for testing purposes – they can shorten battery cycle life and may result in inconsistent charging.
- Testing should be designed around actions, not around a given sequence of button presses. Different cameras have different UI features that may allow quick access to some features. For example, HP cameras have "instant review" which allows the photographer to quickly delete unwanted photos immediately. Yet some battery testing procedures have the tester wait until instant review is done, then switch to review mode to delete the photograph rather than use the instant review delete feature. This extends the time the LCD is on compared to a camera that does not have instant review.
- Testing should include cycles, taking a reasonable number of pictures, then turning off the camera and allowing the batteries to recover for at least several minutes – this is much closer to an actual use model. In fact, many cameras depend on the camera being

turned off and back on periodically to calibrate the battery gauge for the best behavior and longest life. When operated continuously, batteries warm up which makes them behave differently than they would if they were cooler, which is more typical of real use.

- Consistent use of higher power features is critical. Recall, 5 seconds in live preview is approximately equal to a shot in most digital cameras. Clearly, it is extremely important to consistent results that live preview time be maintained faithfully from shot to shot and camera to camera. This is also true of other high-power operations like zooming, strobe, and focus. In the case of the latter three, similar lighting and distance conditions should be maintained across all shots and cameras so that some cameras don't spend a longer time than others focusing before and after zooms, or end up discharging the strobe to different levels.
- Use consistent resolution settings as much as possible. Resolution setting can affect picture save time significantly, which can in turn affect power consumption.
- Allow for more than one automatic turn-off before deciding that the test is over. Most cameras must be somewhat conservative about when they turn off because inappropriate shutdowns due to low power can cause corruption of the memory card. Because camera makers must assume that people may turn the camera back on after automatic shutdown, they have to set the first shutdown slightly above where the batteries are completely dead. Depending on battery chemistry and the load under which the camera shut down, sometimes the batteries recover significantly and can allow many more shots, especially if done in a lower power manner after the first shutdown.
- If possible, replicate results. When doing testing "by hand" with a person pressing buttons, up to 20% variation can be possible between tests even if the person is trying to do the same thing every time. It's always a good idea to make sure that results can be repeated more than once before deciding that they are accurate.

Example Test Scripts

Average Use Model

Set camera to maximum resolution; fill flash off, automatic live preview off (if equipped with optical viewfinder)

1. Turn on camera.
2. Turn on live preview (if necessary).
3. Wait 15 seconds.
4. Do a full zoom in and out (optical only).
5. Take strobe OFF picture and wait for default instant review to end.
6. Turn off live preview (if optical viewfinder equipped) otherwise leave on.
7. Wait 15 seconds.
8. Take strobe OFF picture and wait for default instant review to end.
9. Turn on strobe and live preview (if necessary).
10. Wait 15 seconds.
11. Take strobe ON picture and delete during instant review, if possible.
12. Turn off live preview (if optical viewfinder), leave strobe on.
13. Wait 15 seconds.
14. Do a full zoom in and out (optical only).
15. Take strobe ON picture and delete during instant review if possible.
16. Switch camera to playback mode.
17. Wait 30 seconds.
18. Delete any pictures not deleted in steps above.
19. Turn camera off.
20. Wait 5-10 minutes and repeat from step 1 until the third automatic shutdown.

Heavy Use Model

Set camera to maximum resolution, fill flash forced on, automatic live preview on, if possible.

1. Turn on camera.
2. Start live preview.
3. Wait 30 seconds.
4. Do a full zoom in and out (optical only).

5. Take strobe ON picture and wait for default instant review to end.
6. Restart live preview (if necessary).
7. Wait for 30 seconds.
8. Do a full zoom in and out (optical only).
9. Take strobe ON picture and wait for default instant review to end.
10. Restart live preview (if necessary).
11. Wait for 30 seconds.
12. Take strobe ON picture and delete during instant review (if possible).
13. Restart live preview (if necessary).
14. Wait for 30 seconds.
15. Do a full zoom in and out (optical only).
16. Take strobe ON picture and delete during instant review if possible.
17. Switch camera to playback mode.
18. Wait 50 seconds.
19. Delete any pictures that were not deleted in steps above.
20. Turn camera off.
21. Wait 5-10 minutes and repeat from step 1 until the third automatic shutdown.

Light Use Model

Set camera to minimum resolution; fill flash off, automatic live preview off (if equipped with optical viewfinder).

1. Turn on camera.
2. Turn off live preview if camera is optical viewfinder equipped, otherwise leave it on.
3. Wait 10 seconds.
4. Do a full zoom in and out (optical only).
5. Take strobe OFF picture and wait for default instant review to end.
6. Turn off live preview if camera is optical viewfinder equipped, otherwise leave it on.
7. Wait 10 seconds.
8. Take strobe OFF picture and wait for default instant review to end.
9. Turn off live preview if camera is optical viewfinder equipped, otherwise leave it on.
10. Wait 10 seconds.
11. Take strobe OFF picture and delete during instant review (if possible).

12. Turn on strobe and live preview (all cameras).
13. Wait for 10 seconds.
14. Take strobe ON picture and delete during instant review (if possible).
15. Switch camera to playback mode.
16. Wait 15 seconds.
17. Delete any pictures not deleted in the steps above.
18. Turn camera off.
19. Wait 5-10 minutes and repeat from step 1 until the third automatic shutdown.

CIPA Standard Test

The CIPA (Camera & Imaging Products Association) has recently released a new standard for battery testing. While there are a number of challenges in such a standard, this standard is being reported more widely. The results should allow you to compare cameras, but it is unlikely that any consumer will see precisely what the CIPA battery testing imply. Therefore it is best used as a comparative metric.

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