



Which batteries are best for the EZMotion 3-in-1 Sensor

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The EZMotion 3-in-1 sensor is powered with three AAA batteries. But which type of battery works best? This article goes thru the battery choices and presents results for a long-term test of the four commonly available battery chemistries.

The EZMotion (also sold as the HSM100 by [Homeseeer](#)) is a low-power RF sensor that under normal operation will provide one to two years of operation on a single set of AAA batteries. The battery lifetime is affected by several factors:

- o Battery type
- o Parameter settings
- o Frequency of motion detection and resulting number of RF transmissions
- o Ambient temperature

There are lots of exotic batteries that might give even longer lifetimes but they are not widely available so let's focus on the four basic types commonly available at your local store:

1. Carbon
2. Alkaline
3. Rechargeable (usually NiMH)
4. Lithium

In the US there are three major battery manufacturers:

1. Energizer
2. Duracell
3. Rayovac.

Each of these three manufacturers makes all four battery types in the AAA size required for EZMotion.

A long duration test was performed with seven different batteries. This test was done to see how the lifetime of each type would work in actual operating conditions when used in EZMotion. The batteries chosen for this test were purchased at a local high volume discount store so the batteries should be "fresh". Seven EZMotion units were used for the test so the testing could be done in parallel and under the identical environment of motion and temperature. The average current used by each unit was measured and is within a few percent of each other which is close enough for this test. Technically this isn't a true scientific test as many more EZMotion units with several sets of each type of battery would have made the sample size large enough to minimize any individual variances. But for the purposes of this test the sample size is large enough to draw conclusions based on battery type but shouldn't be used to select one manufacturers battery from another.





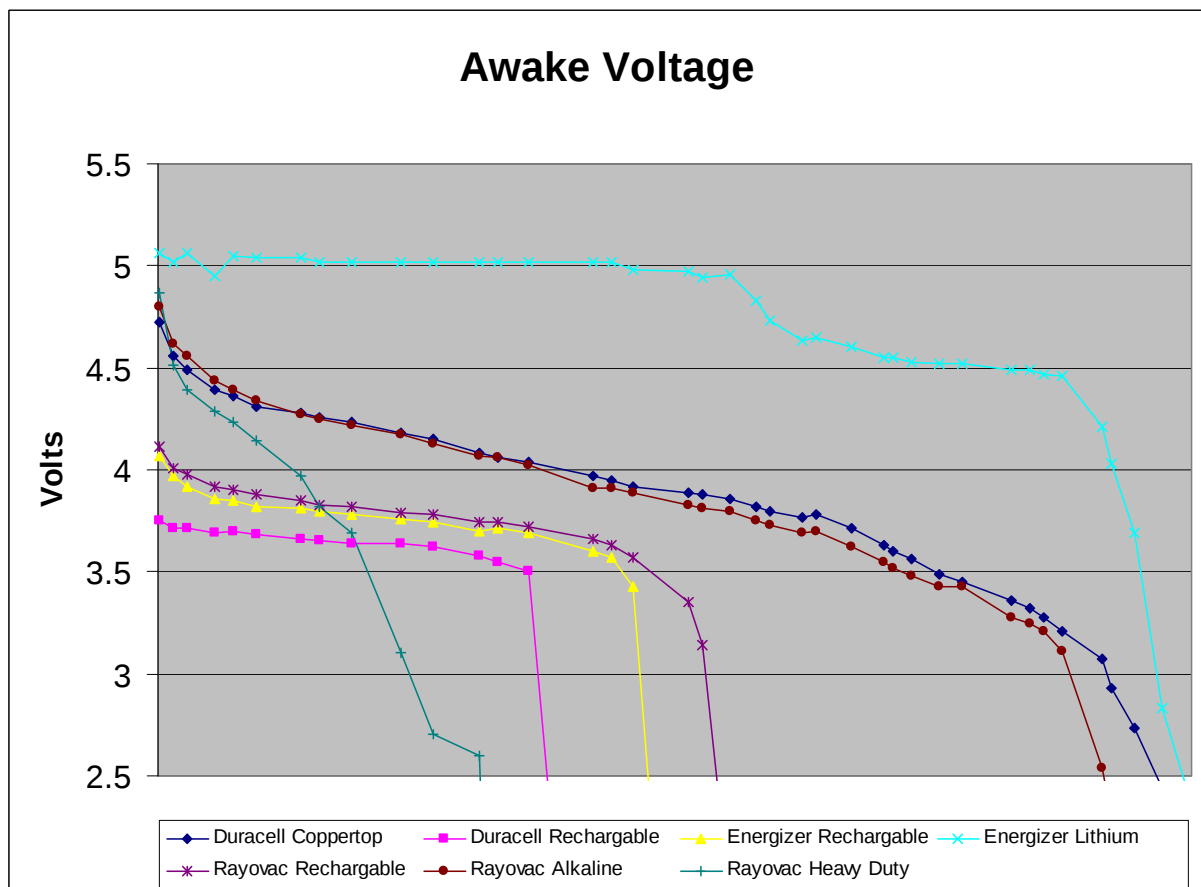
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Batteries used for the test:

Type	Name/Model	Rated Capacity mAh
Carbon	Rayovac Heavy Duty	550
Rechargeable	Rayovac Rechargeable	784
Rechargeable	Energizer E2Rechargeable	850
Rechargeable	Duracell Rechargeable	800
Alkaline	Rayovac Alkaline	1123
Alkaline	Duracell Coppertop MN2400	1150
Lithium	Energizer Advanced Lithium EA92	1200 ¹

The EZMotion units were all started at the same time with the same parameter settings and their voltage was measured every few days. The voltage over time is shown in the chart below:



The results track pretty well with the rated capacity of each battery. The Heavy Duty battery is an old technology Carbon battery that has less than half the capacity of Alkaline cells. The rechargeable batteries are all pretty much the same but still have barely a little more than half the capacity of the alkaline cells. Surprisingly, the “Advanced” lithium battery doesn’t have a significantly longer lifetime than Alkaline cells but it’s voltage profile is very flat until the battery runs low and then the voltage drops quickly. This profile doesn’t help the EZMotion battery level reporting as the voltage will suddenly drop very quickly.

¹ The Energizer datasheet doesn’t give a specific mAh rating but instead just gives a curve which was estimated to provide the 1200mAh



Comparing the cost of the different batteries is complicated by the rechargeable batteries. The Heavy Duty batteries are the least expensive and roughly half the cost of Alkaline batteries. Since they also provide less than half the battery life they really don't make much sense to use in EZMotion. The Advanced Lithium batteries are about 3 times the cost of Alkalines but only provide a small amount of extra battery lifetime. If you can get a good sale on Lithium batteries and want to maximize the time between battery changes then Lithium batteries are a good choice. That leaves the rechargeable batteries. If you can recharge them several dozen times before their battery lifetime becomes so short to be unusable, then that can justify the 3X to 10X price premium over Alkalines. However, assuming you get at least 6 months on a charge, that means it will take five or more years to make your investment in rechargeable batteries worthwhile.

Parameter Settings to Maximize Battery Life

EZMotion has a number of configuration settings that can either extend or shorten battery life. The key to long battery life is to keep EZMotion asleep as much as possible. When EZMotion is sending or receiving information via the ZWave radio, it is using 1000X more battery power than when it is asleep. The defaults have been set to provide 1 to 2 years of Alkaline battery life under normal conditions. There are four parameters that will alter the battery lifetime:

- 1) Wake Up Interval
- 2) Off Time
- 3) Polling for the light/temperature and battery level
- 4) Stay Awake mode

Wake Up Interval

The Wake Up Interval is the amount of time between each Wake Up Report sent by EZMotion. The interval is set using the ZWave standard command WAKE_UP_INTERVAL_SET. Each application software controls this parameter in a different way but in Homeseer 2.0 it is the "Wake Up Interval" in the configuration screen of a HSM100. The default is 60 minutes. Note that this time should be kept as large as possible as other sensor readings are often polled at this time which will increase the battery drain due to the additional radio transmissions.

Off Time Interval

The Off Time Interval is the amount of time from the last time motion was detected until a light is turned off. Note that EZMotion does not send a command each time motion is detected as that would quickly drain the batteries in a room with lots of motion. Instead, EZMotion will very briefly wake up once per minute and check if there is motion. If there is, it goes back to sleep and waits another minute and repeats the process. If there has been no motion for the Off Time Interval, then EZMotion will send an OFF command which will consume a significant amount of battery. The default is 20 minutes which is good for an average room and minimizes the radio transmissions. Off Time should not be set lower than 5 minutes to minimize battery consumption.

Polling the other Sensors

Each time the other sensors (light, temperature and battery level) are polled from EZMotion, battery power is consumed to send this information over the ZWave radio link. If these values are not important then they should not be polled to improve the battery lifetime.



Stay Awake Mode

Parameter 5 of the ZWave configuration is "Stay Awake Mode". This mode can ONLY be used if you are using an external power supply and NOT batteries. When this parameter is set to a non-zero value, EZMotion will never go to sleep and the batteries will only last a day or two. The advantage of this mode is that you can poll and configure EZMotion at any time as it is always awake and of course, you never have to change the batteries. It also becomes a "listening" ZWave node which means it participates in forwarding radio transmissions in the mesh network which will improve the overall reliability of your ZWave network. When EZMotion is in battery powered mode, it is part of the mesh network but does not forward radio transmissions because it is asleep most of the time. Note that "resetting" EZMotion (remove or exclude from the ZWave network) does NOT reset this parameter to the default value (0 which is normal "sleep" mode). If you want to change EZMotion back to battery powered you have to explicitly change the parameter and then reset EZMotion and rejoin the network.

Temperature

The one environmental impact on battery life is the ambient temperature. The battery datasheets show that battery life is longest at normal room temperature of around 70F. Cold temperatures below freezing can significantly shorten battery life as will extremely hot temperatures.

Recommended Battery Type for EZMotion

The recommended battery type for the longest, most reliable operation of EZMotion is to use **standard Alkaline** AAA batteries. Lithium batteries will give just a little more lifetime but are expensive for the small improvement. Rechargeable batteries provide only half the lifetime of Alkaline and their expense will take many years to see any net savings. Heavy Duty batteries cost the least but they won't provide reasonable battery lifetimes making them ultimately more costly than Alkaline.