

Robot Batteries, an overview:

By Tom Bickford, 5/2016

So you want to power your robot. I will cover some general battery information and send you on to better sites for more detailed information.

The RCX (generation 1); the NXT (generation 2); and the EV3 (generation 3) can all run on six AA batteries that are installed in the back of the unit and covered with the provided battery cover. This will result in between about 7.2 and 10 volts with brand new or newly recharged batteries.

All three can also run on rechargeable AA batteries.

The NXT and the EV3 also came with an optional rechargeable battery pack.

Some of these answers have the question about whether they are “acceptable” or not. This applies to use in the [Robot Track Meets](#), which limits total power to 9 volts, or 1.5 volts per AA batter (Section 8.c under general rules).

AA or rechargeable or battery pack:

1. AA Batteries:
 1. Alkaline AA batteries are always acceptable (~1.5V per battery)
 2. Nickle Metal Hydride (NiMH) AA batteries are always acceptable (~1.2V per battery)
 3. Nickle Cadmium (NiCd) AA batteries are always acceptable (~1.2V per battery)
 4. *Lithium Iron Disulfide (Li-FeS₂) AA batteries are rated as 1.5V but actually start out at ~1.7V per battery and are **not acceptable** for use in the Robot Track Meets.* But good for any other time.
2. LEGO Rechargeable Battery packs (both acceptable for the Robot Track Meets)
 1. NXT: I believe these run at 7.4 volts when fully charged, so they do not exceed the 9.0 volt maximum charge.
 2. EV3: These charge to around 8.2 volts and are Lithium Ion batteries and hold a charge very well.
 3. When compared to the alkaline AA batteries, both have a fairly flat voltage curve (they stay at close to full power for a long time) and then drop off fast (so you can get surprised when the battery all of a sudden drops to unusable and needs recharging). Alkaline batteries drop off from the moment you start using them.
3. Battery Amp Hours, this is the amount of energy stored in a battery. More energy, more work can be done or more time the robot can run (as in collect data, etc). Some batteries have been designed for higher energy draw, like those made specifically for things like digital cameras. Others work better/longer when used more moderately.
 1. EV3 battery: 2050 mAh (milli-ampere-hour)
 2. NXT battery: 2100 mAh
 3. Energizer Lithium Ultimate: 3000 mAh
 4. Alkaline AA: 1500-2500 mAh

Lowest voltage acceptable? All types of batteries will run the robots until they drop below a minimum voltage required by the computer (EV3, NXT, or RCX). This is the voltage required to run the chipset that runs the robot.

1. RCX: Sorry, don't remember when it shuts down. Of course you were usually more worried about the battery cover coming loose and having to re-install the firmware and programs...
2. NXT: I seem to remember that the NXT shuts down around 6.8 to 7.0 volts.

3. EV3: Dexter Industries did some power evaluations on the EV3 and found it would run all the way down to 5 volts (amazing) check out their [website](#) to see more.

Why is power level important?

1. The higher the power level (voltage) in your robot, the more power available to run motors on your robot. This power can be translated to both speed and/or strength. Another good website to take a look at is from <http://www.philohome.com/motors/motorcomp.htm> and it shows all the different LEGO motors and down below you can see the effect of voltage on motor speed (unloaded). You'll see that the higher the voltage, the higher the RPM (hence speed). You can also see that more power (higher voltage) also results in a greater torque available from the motors.
2. We saw one very important note from Dexter, if you lock the motors or put them in a situation where they have to draw a large amount of power they will likely start tripping and resetting their built in fuses. So if you are running a strongest robot and the motors can't turn due to the weight or can't turn much, then you are likely to get a twitchy response that has an overall lower output of power. Just food for thought.