

# FAQ: Choosing the Right Lithium Polymer Battery for the MagArrow:

The MagArrow uses a 3 cell Lithium Polymer battery to power the MagArrow during surveys. The two main requirements for the battery are that it must fit into the battery compartment, and it must be nonmagnetic.

## Non-Magnetic Batteries:

Many types of Lithium Polymer batteries are extremely magnetic. This is because the cell-to-cell connections are made with nickel strips (nickel is extremely magnetic). This makes them unsuitable for use in the MagArrow since they will interfere with the background magnetic field that is being measured. Whether or not the batteries are magnetic is not something that appears on the data sheet, so it is important to choose batteries of a particular construction form factor that in practice has been shown to have a very low magnetic signature. Examples of this battery type will be shown below. There are many brand names for this battery type, and the brand names seems to change frequently.

## Evaluating the Magnetic Properties of a Battery:

Batteries should be measured for magnetic signature before using them. This is especially true when trying a new battery brand just to be sure the battery is not going to affect the survey data. To perform this test you will need to start a survey with a stationary MagArrow pointing north-south on a nonmagnetic platform (wooden sawhorses, cardboard box, etc). Hold the battery to be tested immediately over the battery compartment and rotate it in all orientations. Download the data and look for variations in the magnetic field that correlate with the battery rotation. There shouldn't be any correlation above 1 nT peak to peak. Make sure the operator is nonmagnetic when doing this test (shoes, belts, watches, cell phones, keys, etc. can all corrupt the results).

# Battery Size and Shape:

The correct batteries are rectangular in shape and measure roughly 105x34x24mm. They are made from 3 flat cells stacked up measuring 11.1 volts nominal. They should be between 1800 and 2200 mAh (milliamp-hour). Higher capacity batteries will not physically fit in the battery compartment. Lower capacity batteries will work, but with a reduced run time. One 1800 mAh battery will run the MagArrow for about two hours. The MagArrow power connector is XT-60 so the battery must match. There are other power connector types, but XT-60 is commonly used. The 4-pin balance port connector is a JST-XH4 connector (though this is standard on most batteries).



#### Where to Find Batteries:

If you are in an area that doesn't have strict controls on shipping Lithium Polymer batteries, then Amazon.com is a good source. Another good source is hobby stores, or anyplace that sells radiocontrolled toy cars, boats, or airplanes. This is typically where this style of battery is used the most.

# What do the Battery Specifications Mean?

3S: This means it is a stack of three Li-Po cells

**Voltage**: A fully charged 3 cell Li-Po battery measures 12.6 volts. A depleted battery will measure 9.6 volts. Thus, the voltage for this battery is typically labeled as 11.1 volt (the average of 12.6 and 9.6 volts.

**35C (or any other "C" value):** This is a rating on how much current can be safely drawn from the battery. To get the value in amp take the milliamp-hour rating and divide by 1000 (to get amp-hours), and then multiply by the "C" value. For a 2200 mAh battery with a 35C rating multiply the 2.2 amp-hour capacity (2200 mAh / 1000) times the C value of 35, which gives a maximum discharge current of 77 amps. The MagArrow draws about 0.6 amps, so any C value is fine - even if is down to 0.5.

# Battery Chargers:

Most battery chargers being sold now are universal chargers which support a variety of rechargeable battery chemistries and output connectors. They come in many sizes and shapes, but most of them operate identically because the internal circuitry is the same. Most chargers will charge at a much faster rate than the MagArrow discharges them, so you technically only need two batteries in the field. A nice feature to look for is the ability to power the charger off 12V as well as with AC power. This will allow charging in the field off a car battery.

Be sure to charge in batteries in "Balanced Charge" mode using the battery balance JST-XH connector. This allows more charge current into cells that are more deeply discharged than the others and ensures that the battery gets all three cells completely charged.

# **Battery Safety:**

Lithium Polymer batteries are small and light but store a tremendous amount of energy inside. This is good for running equipment for long periods of time between charges, but it also means that if something goes wrong and it releases all its energy at once it can be a serious fire hazard.

- 1. Never charge a lithium battery unattended, charge only in a fireproof location.
- 2. Batteries that are swollen or damaged should not be used. Dispose of these per local regulations



- 3. Be sure to follow all regulations for shipping or hand carrying Li-Po batteries. This may include packaging and labeling requirements, limiting the number of batteries, and discharging the batteries to 30% capacity before shipping.
- 4. Do not discharge the battery below 9.6 volts (3.2 volts per cell). This damages the battery and could result in destructive decomposition and fire. If a battery that is discharged below a safe level is placed on the battery charger it will refuse to charge it. Batteries that are discharged below 9.6V should be removed from service and disposed of according to local regulations.

## Some Examples of MagArrow Batteries (and Charger):

