BIRT: Battery Internal Resistance (IR) Tester Instructions

All you ever wanted to know in one compact device with color touch screen!

Battery condition is important to enjoy our hobby yet most people do not really know when a battery has outlived its usefulness. Or whether a cell in the battery might be going bad. BIRT displays on one screen every cell's condition in easy-to-understand terms.

It's easy to use, simply plug in the battery and set the battery capacity then BIRT goes to work. Small enough to keep in your tool or flight box.

BIRT uses standard XT60 main connector and JST balance connectors.

So why do you need one?

Introduction to Internal Resistance

Internal resistance (IR) is the most important parameter in determining the health of a battery. While there is not an actual physical resistor in the battery or in each cell, when a battery is supplying current it acts like a resistance. Obviously the lower, the better because you want to get as much current as possible to your speed controller.

Each cell in a multi-cell battery acts like it has resistance when loaded. The key is to have each cell resistance relatively the same. In a string of cells, it only takes one high resistance cell to limit the output. BIRT will give you the cell resistances of each cell. It also calculates the continuous current the complete battery can output without overstress. And it gives a "C" rating for each cell and for the complete battery.

Note: C ratings published by battery manufacturers are not accurate. BIRT measures under a load which is drawing power. This is the only way to determine real world C rating.

Technical Information

A real-world battery can be modeled or simulated by an "ideal" battery (i.e., voltage does not change with current) and an equivalent series resistance we call IR. IR is typically measured in milliohms (1/1000 of an ohm) and is generally a few milliohms per cell, 1-2 milliohms for a high (3500-5000) mAh battery and higher IR for smaller mAh batteries. IR degrades (increases) over the life of the battery and may show a sharp increase if the battery is failing. Each cells' IR should be similar for a healthy, balanced battery. IR is relatively independent of the battery State-of-Charge (SoC) if the SoC is over 15%. However, IR is ***strongly*** dependent on temperature and will decrease by about half over a 20 deg F increase in temperature. So, the IR will measure lower after a flight when the battery is warm, or higher when unused on a cold day. For comparison purposes, batteries must be at the same temperature (which can take 1-2 hours to stabilize).

How to Use the Meter

The Battery IR Tester measures the IR of each cell in a battery for 2- to 6-cell batteries. To use the Battery IR Tester, plug the battery power connector into the XT60 connector and the balance plug into the balance connector. For batteries less than 6 cells, the battery's balance plug can be plugged into any location on the Tester's balance connector. After the opening screen, and after the balance connector is plugged in, the Meter will ask for you to enter the battery mAh capacity. Press the up and down arrows to enter the battery's mAh capacity. Note that this display also shows the battery voltage and number of cells. (On rare occasions, if the balance connector is mated slowly, the correct number of cells may not be correctly measured. If this occurs, just temporarily disconnect the battery power connector and reconnect.)

After you press "OK" the Battery IR Tester will measure and display the voltage, IR, the maximum continuous current, and the maximum continuous C for each cell. The current and C values are for continuous safe operation – what you can operate continuously without damaging the battery from excessive temperature rise. Since the current and C values are for continuous safe operation, these values are usually significantly less than the overly (often ridiculously) optimistic battery manufacturer claims. Manufacturers often claim excessively high values that cannot even be achieved in pulse operation (and I'm being kind in representing manufacturers' claims). Unfortunately, there is not a standardized method of pulse testing among battery manufacturers.

The Battery IR Tester also calculates and displays a Figure of Merit (FoM). The FoM is useful for comparing different batteries (i.e., different manufacturers, different mAh capacities, etc.) or comparing a specific battery over the lifetime of the battery. Keep in mind that since IR is highly temperature dependent, the maximum continuous current, maximum continuous C, and FoM are also temperature dependent, so any comparison tests need to be made at the same temperature, ideally 72 deg F. (The calculation of maximum continuous current, maximum continuous C, and FoM are based on the empirical work of Wayne Giles and Mark Forsyth and based on testing at 72 deg F.)

The Battery IR Meter is primarily intended for LiPo batteries. While the measurement of IR is independent of battery chemistry (i.e., LiFe, or even NiMH), ***the calculations for maximum continuous current, maximum continuous C, and FoM are only valid for LiPo batteries at 72 deg F.***