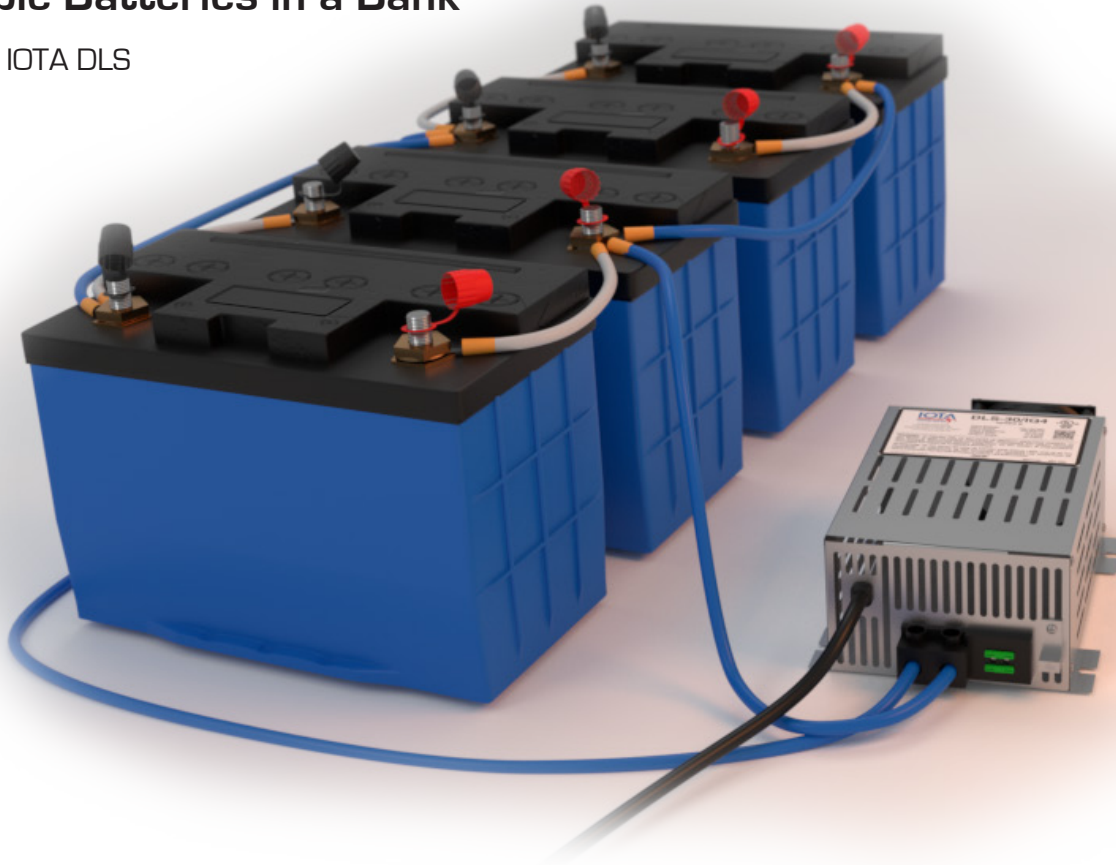# Optimal Charging for Multiple Batteries in a Bank

With the IOTA DLS

Content Highlights

→ **The effects of resistance between lead connections in multi-battery banks.**

→ **Countering lead resistance through the "Balanced Charging" wiring method.**

→ **The optimal "Balanced Charging" wiring method for maximum battery life and performance.**

When connecting multiple batteries in parallel to create a larger battery bank, it turns out that "not all batteries are (necessarily) treated equal." Depending on your connection method, some batteries can be charged harder, worked harder, and discharged faster than others. Harder working batteries will typically fail sooner than the other batteries in your bank, and, in some cases, will fail early in their expected lifespan. The culprit is a small, yet impactful amount of resistance between your battery connections. **"Balanced Charging"** is a way of eliminating this problem by evenly distributing the resistance between the connections across all of the batteries, allowing you to reap the maximum potential of each battery, and ensuring that they all have a similar, lengthy lifespan.

Effect of Resistance in an Unbalanced System

Realizing the effects of resistance on batteries connected in parallel is best demonstrated through a common method of wiring them (see Figure 1). In typical applications, the batteries are connected side-by-side (negative to negative, and positive to positive), starting with the first battery connected to the second, and so on until connecting to your battery charger.
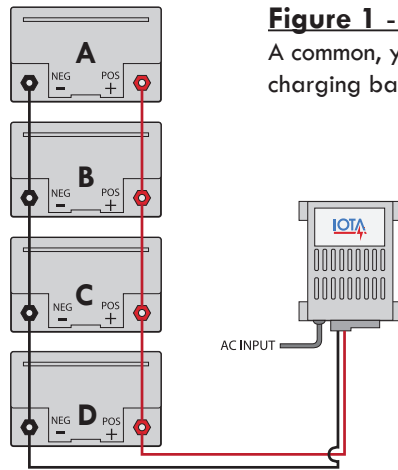

Figure 1 - Unbalanced Charging
A common, yet inefficient way of charging batteries in parallel.

Theoretically, each battery would be receiving the same amount of current when charging, however, small yet measurable amounts of resistance between each battery connection makes this not the case. In reality, the battery connected directly to your charger (in this example, battery D) will draw more amperage than the battery furthest down the bank, as the current is reduced through each interconnecting lead.

This difference in current between the closest and furthest batteries from your charger can be very significant (often up to twice the amount of current drawn by the closest battery, see Figure 2), and this effect only increases as additional batteries are added to the system.

Approximate Amperage Drawn Per Battery if the Charger is Providing 50 Amps.

Draws 8.9 Amps
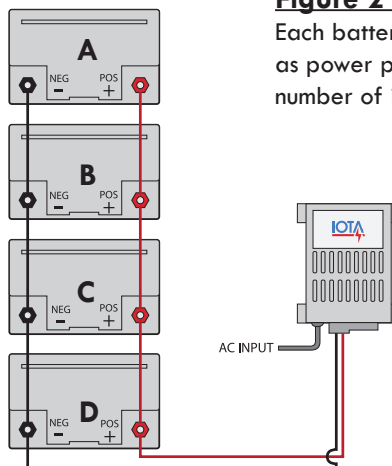
Draws 10.2 Amps

Draws 13.1 Amps

Draws 17.95 Amps

Figure 2 - Unbalanced Charging
Each battery draws less amperage as power passes through an increasing number of interconnecting leads.

To counter this, your batteries should be wired with **"Balanced Charging"** in mind, which basically means that **the total number of leads that separate your battery from the charger is equal for each battery.**

Method 1 for Balanced Charging

The first and easiest method to achieve 'Balanced Charging' is to simply reverse direction of one set of leads and wire them starting from the opposite end of the battery bank (see Figure 3). By doing this you have achieved the criteria of 'Balanced Charging'- each battery will draw current through exactly three interconnecting leads. However, this method of wiring is still not perfectly balanced.

Approximate Amperage Drawn Per Battery
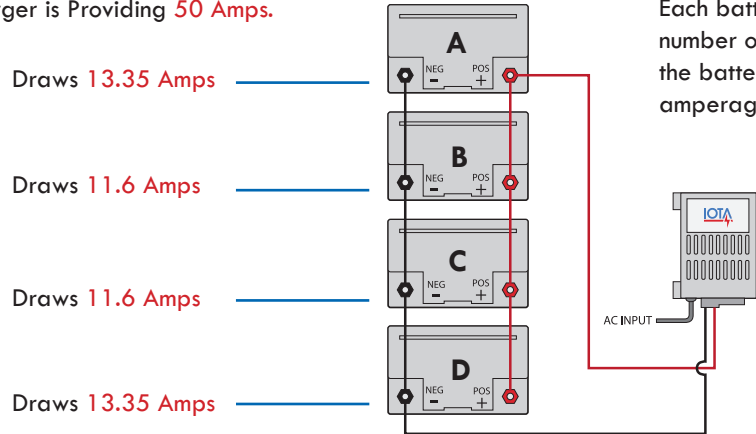if the Charger is Providing 50 Amps.

Draws 13.35 Amps

Draws 11.6 Amps

Draws 11.6 Amps

Draws 13.35 Amps

Figure 3 - Balanced Charging
Each battery draws power from the same number of interconnecting leads. However, the batteries are not yet drawing equal amperage.

While the total number of interconnecting leads is equal for each battery, some of the links still draw more total current than others, and therefore will experience drops in voltage along their length.

This wiring method is still a large improvement over the traditional method, and may be suitable for most applications (especially if space is a concern and extra wiring is not a possibility). Another wiring method exists, however, that allows for 'Perfectly Balanced Charging.'

Method 2 - Perfectly Balanced Charging

In addition to the need for a consistent number of interconnecting leads for each battery, the **length (and wire gauge) of the battery leads should also be consistent** to achieve 'Perfectly Balanced Charging.' This final wiring method illustrated in Figure 4 shows modified connections to reduce additional resistance.

Approximate Amperage Drawn Per Battery
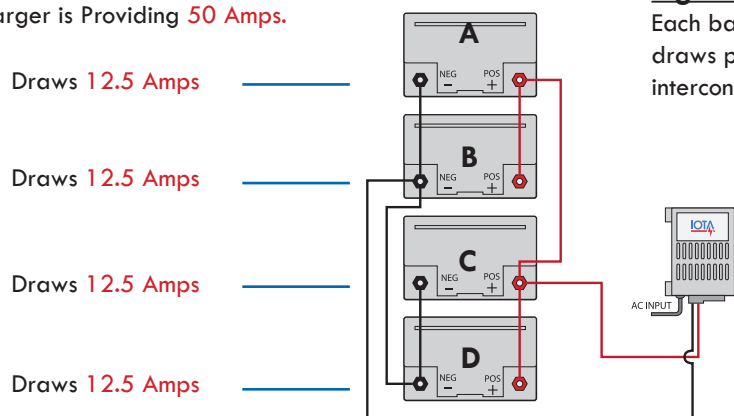if the Charger is Providing 50 Amps.

Draws 12.5 Amps

Draws 12.5 Amps

Draws 12.5 Amps

Draws 12.5 Amps

Figure 3 - Perfectly Balanced Charging
Each battery is drawing equal amperage, and draws power from the same number of interconnecting leads.

The benefit of this wiring method is that each battery draws current from one long lead and one short lead before reaching your charger. In this way, the total number of interconnecting leads between each battery and the charger is the same, and the total length of these leads is the same for each battery. Note: it is also important that the wire gauge of these leads is also consistent, otherwise changes in resistance will still exist.

Method 2 - Perfectly Balanced Charging (Continued)

Now your battery bank is 'perfectly balanced' and each battery will draw the same amount of current for the charger, meaning that your entire bank will charge equally for optimal life of all the batteries in the bank.

Note: even though the examples demonstrated this wiring method on four batteries, this method can be employed on any battery bank containing an even number of batteries (ex: 6, 8, 10). As long as each battery is connected to your charger through the same number of interconnecting leads, and the total length and gauge of these leads is the same, perfectly balanced charging can be achieved.

Implementing 'balanced charging' is a way to ensure that your batteries last as long as possible, and provide you with the output performance you require. For more information about using the IOTA DLS for Perfectly Balanced charging, and getting the most out of your battery investment, contact **IOTA Customer Support at 1-800-866-4682.**