

### Current Technology Analysis

The CCCV (Constant Current, Constant Voltage) charging method is a widely used technique for charging lithium-ion batteries. It ensures safe and efficient charging by following a two-stage process: constant current (CC) and constant voltage (CV).

#### 1. Constant Current (CC) Stage

In this stage, a constant current is applied to the battery. The goal is to begin charging the battery and gradually increase its voltage. During this stage, the voltage of the battery increases, while the current remains fixed.

- As the voltage increases, the capacity of the battery is also increased.
- This phase typically starts when the battery is empty and continues until the battery's voltage reaches a specific level, which is typically close to the battery's nominal voltage.
- The constant current stage is the first part of charging, where chemical reactions inside the battery start to store energy.

#### 2. Constant Voltage (CV) Stage

Once the battery voltage reaches a certain level (usually around 4.2V per cell), the charger switches to a constant voltage mode and begins to reduce the current gradually. This stage starts when the battery is nearly full.

- The voltage is kept constant, and the current gradually decreases.
- The current continues to drop as the battery nears full charge. This stage prevents overcharging the battery.
- This phase is crucial because lithium-ion batteries can be damaged if charged beyond a certain voltage.



#### Pulse Charging:

Pulse charging is an alternative charging method where current is applied in short bursts or pulses rather than a continuous flow, which can provide several advantages, especially in terms of battery longevity and efficiency. Let's break down how pulse charging works and its benefits.

#### What is Pulse Charging?

In pulse charging, instead of supplying a constant current to the battery, short bursts of current are applied at intervals, followed by periods of rest or low current. This pulse-and-rest pattern is repeated throughout the charging process.

### Key Characteristics of Pulse Charging:

1. **Pulsed Current:** The charger sends short bursts of current to the battery for a specific duration, followed by a pause or reduced current. This cycle repeats multiple times during the charging process.
2. **Pulse Duration and Frequency:** The duration and frequency of the pulses can vary depending on the battery type and the charger. These pulses are typically optimized for the specific battery chemistry used.
3. **Cooling Intervals:** Between each pulse, the battery has time to cool down, reducing the risk of overheating compared to continuous charging.

### How Pulse Charging Works

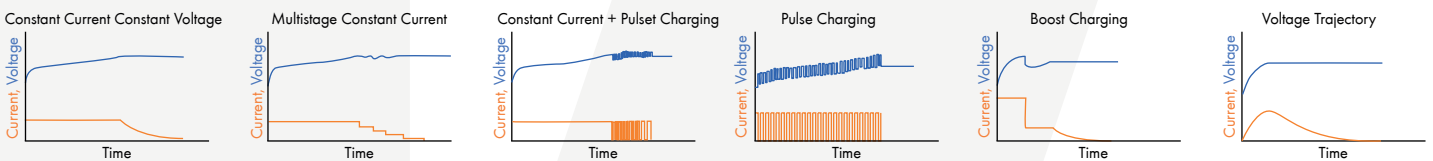
1. **Charging Phase:** The charger applies a burst of current to the battery for a short period, which increases the battery's voltage and begins the charging process.
2. **Rest Phase:** After each pulse, the charging current is either reduced or completely stopped for a brief period. This allows the battery's internal structure to stabilize and cool down.

### Benefits of Pulse Charging

1. **Reduced Heat Generation:** Continuous current charging can lead to battery heating, but pulse charging reduces this by giving the battery time to cool down between pulses. This helps prevent overheating, which can extend battery life.
2. **Efficient Charging:** Pulse charging can improve the efficiency of charging by allowing the battery to charge more effectively during each pulse. This method is particularly effective for lithium-ion and similar battery types.
3. **Less Chemical Degradation:** Continuous charging can cause chemical degradation inside the battery. Pulse charging reduces this degradation, helping the battery maintain its health for a longer period.
4. **Faster Charging:** Pulse charging can speed up the charging process since each pulse allows the battery to charge more efficiently compared to continuous charging.

*"A new charging protocol for the lithium-ion battery, involving a short relaxation periods and short discharge pulses during charging appears helpful in eliminating concentration polarization and increasing the power transfer rate. This lowers the charging time and improves the active material utilization, yielding higher discharge capacity and longer cycle life."*

(The effects of pulse charging on cycling characteristics of commercial lithium-ion batteries, Jun Li, Edward Murphy, Jack Winnick, Paul A. Kohl)



### Cycle Management System

At **Werer Energy**, we are developing a product called the **Cycle Management System (CMS)**, which is designed to extend the lifespan of lithium battery packs. This system connects to the input of the battery pack and applies **Pulse Charge** during charging to improve the battery's charging cycle and increase its **cycle life** (the number of charge-discharge cycles).

CMS is an **intelligent circuit board** equipped with essential components, including **MOSFETs** (Metal-Oxide-Semiconductor Field-Effect Transistors). These components ensure high efficiency and safety during the charging process. Additionally, the system can be **customized** for each **battery chemistry** and **capacity**, allowing it to provide optimal charging management based on the specific characteristics of the battery, ensuring its longevity and healthy performance.

CMS is a **programmable system**, meaning it can be configured to suit various battery types and their unique properties. This flexibility enables the system to implement optimized charging strategies tailored to different chemistries and capacities. The Pulse Charge technique reduces chemical degradation inside the battery and prevents overheating, ultimately prolonging the battery's lifespan.

In summary, the **CMS** performs efficient charging operations while maintaining battery health, ensuring longer-lasting and more reliable performance for lithium battery packs.