

Output AC Ripple Effect

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The battery charging process is one of the most critical factors that impact the performance and service life of lead acid batteries. Charging is normally done with a DC voltage source that can be adjusted to optimize the charge process. As such, a battery charger is an electrical/electronic device that converts the incoming AC line voltage into a regulated DC voltage to meet the battery charging needs.

Not all battery chargers generate a clean DC output. In fact, most of today's charger technologies, e.g. ferroresonant and SCR, utilize single-phase or three-phase rectifiers to generate a DC voltage off the incoming AC line. The output of these rectifiers is a DC with an AC component superimposed on it (see Fig. 1). This gives rise to **AC voltage ripple**, which results into a **ripple current** flowing into the battery. Note that the ripple current can be quite high, especially if the battery internal impedance is very low.

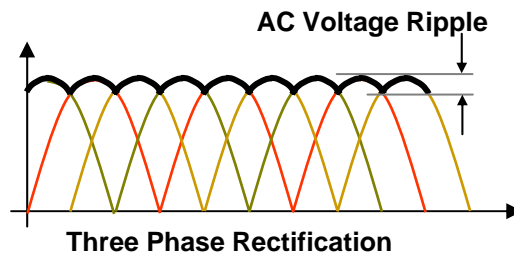


Fig. 1: AC voltage ripple due to rectification

Although there is anecdotal evidence on the impact of ripple current on batteries, it is widely believed that ripple current is undesirable as it leads to an increase in battery temperature due to the additional internal heating and power loss. In addition, ripple currents may speed up the positive grid corrosion leading to premature failures. As a result, most battery manufacturers recommend that the ripple current should not exceed 5% of the battery Ahr capacity (e.g. 5A rms for every 100Ah of battery capacity). Although ripple currents may have little effect in conventional charging, their effect will be quite higher with fast charging.

One way to reduce the output AC voltage ripple in conventional ferroresonant and SCR chargers is by incorporating additional output filtering. However, the added inductance required is relatively high, bulky, and sizeable. Switchmode chargers, on the other hand, offer a novel solution to the ripple problem.

Unlike ferroresonant and SCR chargers, switchmode battery chargers generate very low levels of AC voltage ripple. By using advanced switching power devices, such as MOSFETs and IGBTs, switchmode chargers can operate at frequencies much higher than line frequencies (few kHz to 100's of kHz) allowing for precise control of the charger output. A typical switchmode charger takes the unregulated DC voltage generated by an input rectifier, chops it at high frequency (HF), then filters it out to generate a smooth, very low ripple output voltage (see Fig. 2). In simple terms, a switchmode charger employing MOSFETs or IGBTs rides over the AC ripple generated by the input rectifier to generate a smooth and ripple free DC output voltage, thus eliminating the AC ripple effect.

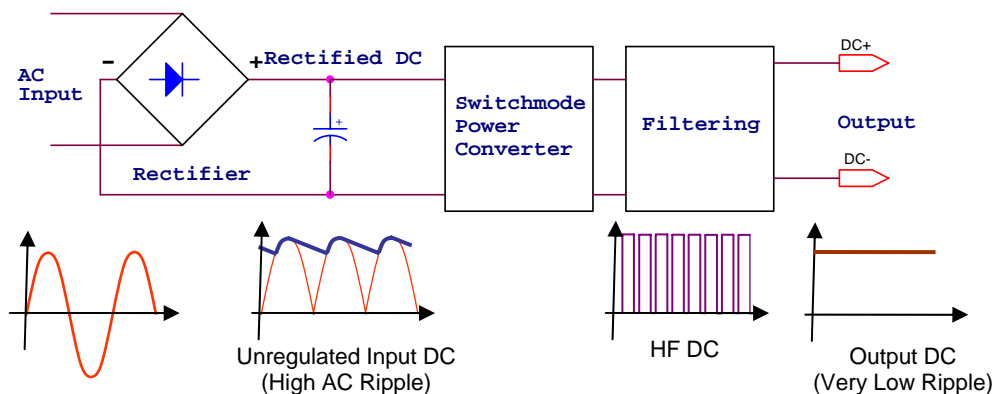


Fig. 2: Typical switchmode battery charger