Why use programmable DC power supplies to charge batteries, specifically Lithium-ion ones?

Customers often submit requests for medium- or high-power battery chargers to serve various projects connected to vehicle electrification (EV), such as e-bikes, hybrid or full electric cars or trucks. These battery chargers are often used as part of a test rig for batteries in an EV environment to carry out cycle, performance and age tests. Those test rigs will usually be provided with control, monitoring and safety mechanisms matching the type of battery they are going to test.

Control and safety mechanisms incorporated in test rigs are typically:

- Control of charging voltage, current and power

- Monitoring

- Reverse polarity protection (to avoid damage as a result of reverse polarity connection)

- Voltage equalisation (to avoid causing sparks from battery to DC source and vice versa)

- Battery cell temperature monitoring

- Battery voltage/current distribution (to each cell in the string and its monitoring)

- Emergency disconnection in case of malfunction (e.g. by safety relay)

- Visualisation

Such test rigs aimed at battery testing will require a programmable DC power supply with adequate interface (analogue or digital, e. g. CAN) with high precision, good resolution and low ripple. It can serve as an adjustable and highly flexible DC power backbone, enabling the test rig to connect to numerous different types of battery cells or battery packs with differing nominal voltage and capacities.

The test rig itself will typically be provided with a switch (mechanical contactor or a semiconductor relay) to securely disconnect DC source and battery in conditions of malfunction or battery under test (BUT) swap. Likewise, the test rig will be provided with a reverse polarity control device that will check for correctly connected polarity and level of voltage of the BUT (equalisation test) before allowing the charging process to start. Both, polarity and equalisation check will control the safety contactor between the DC source and the BUT (see figure 1).

Conclusion I

The test rig will not require a fully featured "automatic DC battery charger" duplicating all those functions with additional costs since they are already contained in the test rig. The programmable DC power supply will merely be required to operate as a constant current and constant voltage source (I-U charging) with auto crossover capability plus having a low ripple, specifically when connecting Lithium batteries.

What is the polarity check for?

Automatic industrial battery chargers (e.g. EA-BCI series of automatic battery chargers) feature a false polarity check. The above mentioned test rig should also contain this. When connecting a BUT (battery under test) to such test rig or EA-BCI series charger, the output relay status is OFF. Both, test rig and BCI would then do the following:

a) Check the connected BUT for correct polarity.

   Note: if a battery is connected to a DC power source with reverse polarity it will cause something similar to a short-circuit and can heavily damage the DC source's output circuit (see figure 2).

In case the polarity is correct, it would then:

b) Check the BUT's voltage to set the DC source's output voltage to the same level as of the BUT.

   Note: a switching mode DC power source has a very energetic capacitance on the output, serving as output filter. If this filter is discharged and a battery is going to be directly connected to it, the result will be a sudden high-energy discharge from the battery into the filter and subsequently cause a heavy spark (see figure 3). Only if correct polarity is detected and the voltage levels of DC source and BUT have been equalized, the output relay will be set to ON status and subsequently connect DC source to battery, allowing to initiate the charging process.

Conclusion II

Programmable DC power supplies of, for example, series PSI 9000 or PS 9000 can be used as I-U charger in such battery test rigs. The power supplies themselves do not necessarily need to have <u>protective output relays or extra voltage-equalization (anti-spark function)</u>. They need to be programmable, reliable, flexible (ideally auto-ranging) and have a low ripple.
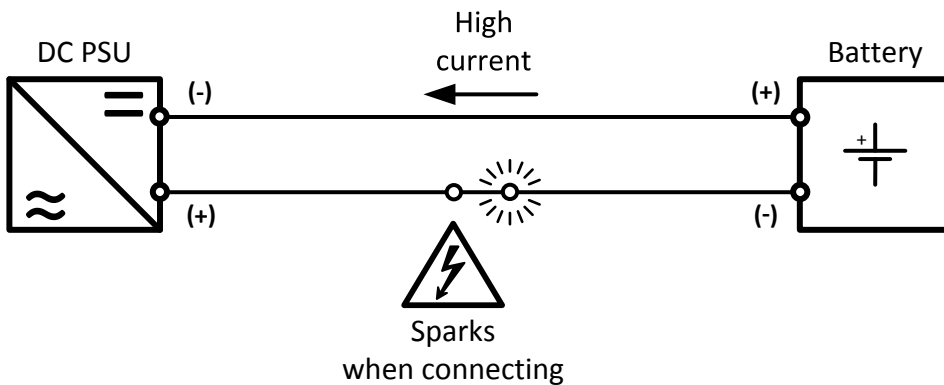
Figure 1

DC PSU · Safety contactor · Battery

(-) (-)

(+) (+)

&

Schmitt Trigger *

Polarity supervision **

+/- ?
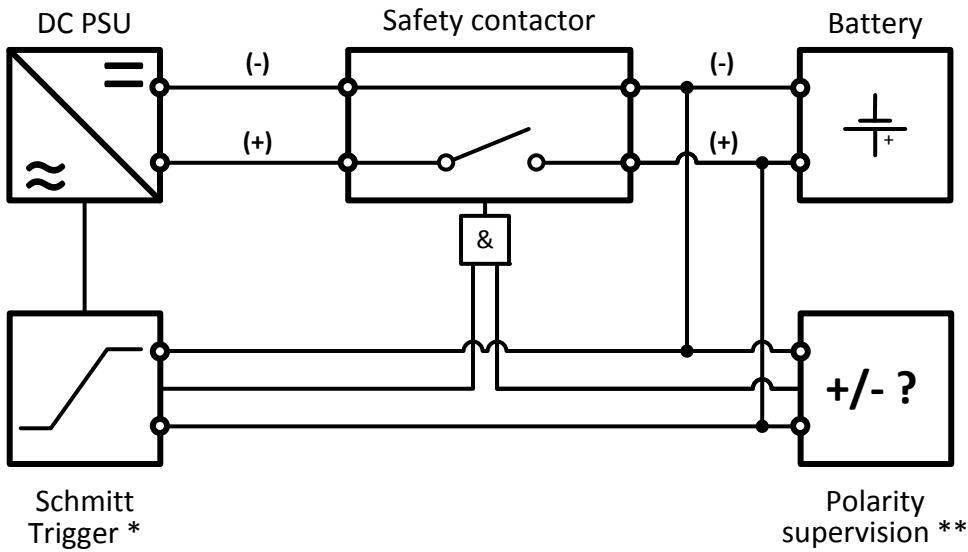
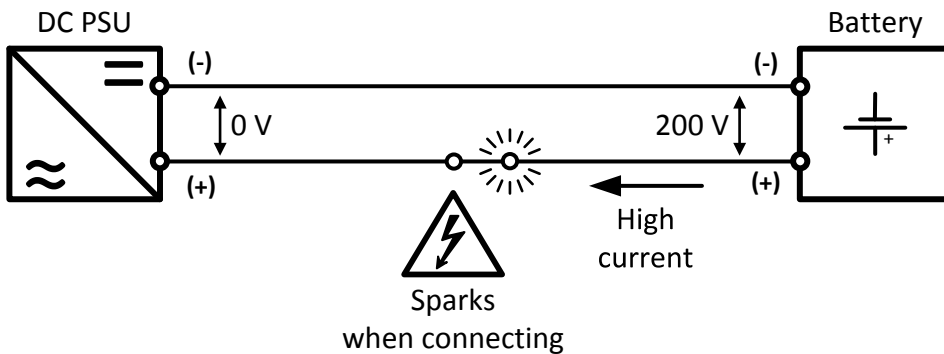Ideal setup for high power battery charging and management

* Voltage level supervision circuit to set the PSU's output voltage to the battery voltage prior to enable the safety contactor
** Supervises correct polarity of the battery connection and enables the safety contactor

Figure 2

DC PSU · Battery

High current

(-) (+)

(+) (-)

Sparks when connecting

No setup = damage due to false polarity connection

Figure 3

DC PSU · Battery

(-) (-)

0 V · 200 V

(+) (+)

High current

Sparks when connecting

No setup = damage due to connection to PSU with discharged caps (i.e. low output voltage)