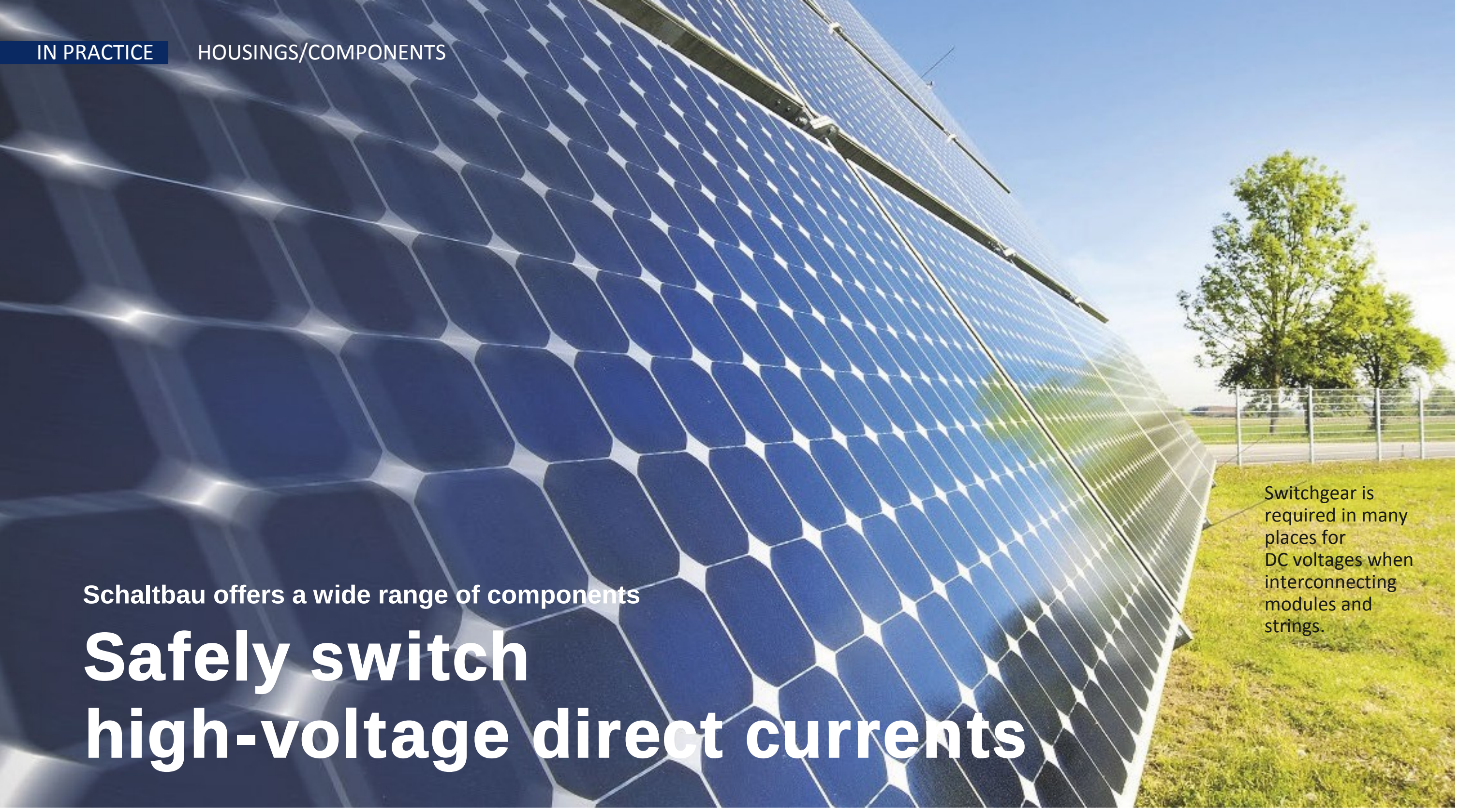


Switchgear is required in many places for DC voltages when interconnecting modules and strings.

Image: Schaltbau

Schaltbau offers a wide range of components

Safely switch high-voltage direct currents

Due to climate change and the nuclear phase-out, many countries are expanding their renewable energy generation capacities significantly. This development and simultaneous growth in the electromobility sector are constantly creating new challenges for the electrical infrastructure. Industrial companies are also giving intense thought to expanding direct current networks. Switching high-voltage direct currents is particularly important in these applications.

Andreas Degwerth, Head of Contactor Development at Schaltbau GmbH in Munich

Individual solar cells are interconnected in modules to generate electricity, creating useful voltages and currents. Depending on the system size, the modules are grouped in strings, with their DC voltage being fed into the grid via an inverter. When planning systems of this kind and choosing electrical protective devices, all faults that could potentially occur must be considered. The electrical equipment is selected based on an evaluation of all electrical operating conditions of the system. The goal is to reliably prevent risk to persons and damage to the system.

Photovoltaic systems and energy storage facilities

Partial shading is a frequently discussed operating condition of photovoltaic systems. When photovoltaic modules are connected in series, a shaded solar cell acts as a diode in the blocking direction and, as a result, there is a very high voltage present there. Connecting bypass diodes in parallel to the cell, or choosing another form of circuitry, counteracts this effect. If shading occurs in a string connected in parallel, a partial current can be generated in the opposite direction. Another source of faults in photovoltaic systems are isolation faults in individual modules or in their circuitry; in extreme cases, the sum of the short-circuit currents of all unaffected strings flows into the faulty branch as reverse current. Faults of this kind can be avoided by using block diodes in a series of modules of a string. String fuses can also disconnect reverse current more or less quickly. Depending on the size and/or complexity of a photovoltaic system, electrical switchgear is used in various places for all-pole disconnection of each individual string. If isolation faults occur, it can take a few minutes for line fuses to trigger. If switching operations are performed during this time, currents many times the nominal current of the string must be disconnected in the reverse current direction. Polarised switchgear with permanent magnets for arc quenching fail in these situations. As a result, only polarity-insensitive equipment is approved for this application.
Energy storage facilities are required to adapt the timing of generation and consumption. They absorb excess energy and output it at a later stage. For example, capacitors and batteries are installed in the vicinity of photovoltaic systems. Here too, appropriate protective devices must be present and equipment must be provided to switch DC voltages.

Switching direct currents

When switching currents with electromechanical switchgear, an electric arc is created. Plasma forms between the contacts, which can irreparably damage the switch in the worst case scenario. While the electric arc is quenched in most cases on the next zero crossing of the voltage in most cases with AC voltages, this naturally does not work for DC voltages.

The 310-series DC switchgear works with permanent-magnetic blowout technology

C310A 300 without arcing chamber

As a result, additional precautions must be taken to quench electric arcs in DC voltage switches. Electric arcs and/or their voltage requirements are described by the electric arc equation:

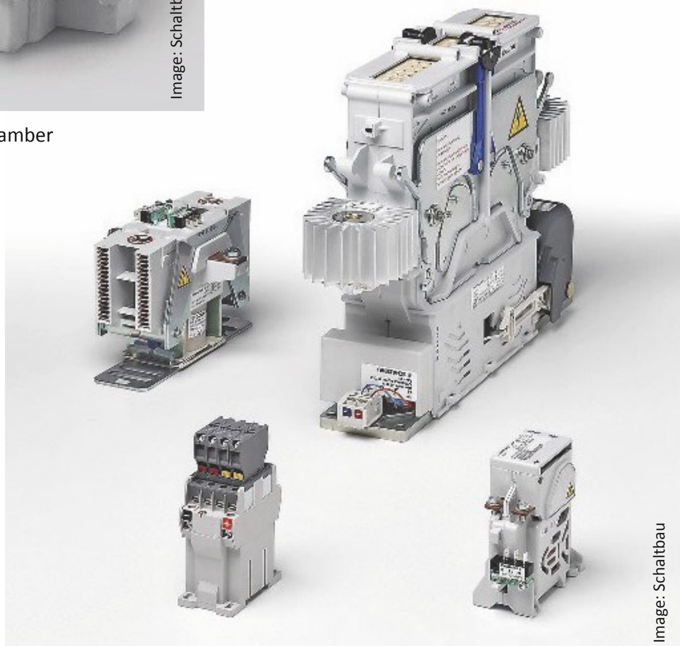
$$U_{Arc} = U_{Anode\ drop} + E_{Column} * L_{Column} + U_{Cathode\ drop}$$

The electric arc voltage must be increased to permit current-limiting switching. You can choose from a range of design measures for this. The principal arc quenching mechanisms are extending the arc column, constricting it, or cooling. Depending on the switchgear, individual mechanisms or a combination of mechanisms are used. The Lorentz force is used for arc extension. A magnetic field, is generally generated by a permanent magnet, deflects the electric arc, thus extending it. This mechanism is also known as magnetic blowout.

If the electric arc comes into contact with the cool walls of the switching chamber or with ceramic elements within the switching chamber, this increases the electric column field strength. If only a few load disconnections are required for the switchgear, out-gassing polymers can also be used. The hydrogen emitted also cools the electric arc additionally by flowing.

Constricting the electric arc between plates of insulating material, which also have a meandering structure, also increases the electric column field strength. As the column diameter is proportional to the level of the load current, the arc is more or less immersed in structures of this kind. By dividing the total arc into partial arcs, the anode and/or cathode drops can be used repeatedly. The short arcs are also additionally cooled by the highly thermally conductive metallic sheets.

To permit cooling with special quenching gas, the switching chamber must be encapsulated to make it gas-tight. The chamber is filled with a mix of hydrogen, nitrogen or sulphur hexafluoride gases during production. The gases have a higher dielectric strength than air and have higher thermal capacities, which leads to better cooling. Switchgear like this can generally only be used for ohmic loads.



Schaltbau GmbH offers a wide range of switchgear for DC applications

Choosing switchgear

There are different requirements for switchgear in direct current circuits depending on the application and individual design of the system, especially in the event of faults. In the C310 series, Schaltbau offers a reliable alternative to the gas-encapsulated devices often used prior to this. The first models of the new series are designed for continuous currents of 150 A, 300 A and 500 A. The modular concept permits the use of a quenching chamber for 60 V, 1,000 V or 1,500 V on the same basic device. These chambers are based on permanent magnet technology, keeping dimensions compact and weight low. By regulating the coil current, these devices operate with constant reliability, regardless of the ambient temperature. This also keeps the energy consumption of the monostable design low when switched on. By design, the bistable version has no power draw in both end positions. The contactors in the C310 series have both a high making and breaking capacity, as well as a high rated short-time withstand current. As both current directions are controlled safety, the contactors are ideal for all applications with energy recovery.

www.schaltbau-gmbh.de

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Further details on the contactors:
http://hier.pro/bKUHI
Hannover Messe: Hall 11, Stand D27