A concept for a DC network in industrial production

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DC networks offer interesting advantages in industrial production. Reduced downtimes are expected compared to AC networks, because an AC line fault will be separated immediately from the DC network via the infeed rectifier, while storage devices connected to the DC network allow continuing its operation. In addition, reduced conversion losses for regenerative energy sources are expected, as those may directly operate on the DC network via their optimizers instead of feeding into the AC network via an active infeed converter and an additional rectifier feeding the DC consumers. For the same reason, energy between braking and accelerating loads is exchanged without any active control.

All devices will be connected to the DC network without inductive components to avoid low frequency and weakly damped resonances. As a consequence, large DC link capacitors will operate in parallel. The design of proper protection devices will be challenging due to the fast rise and the absence of natural zero crossings of fault currents, in particular as low on state losses are required as well.

In an ideal DC network, a fault condition in one component does not have any impact on other devices. However, this would require an individual protection for each component. As protection is more difficult in DC network, a suitable compromise between the number of protection devices and acceptable impact from one consumer to another has to be found. As a solution, the DC network is organized as a parallel connection of load zones. Each load zone includes one protection device to the overall DC network, while consumers inside one load zone are operating directly in parallel. The concept allows the assignment of components to load zones for each production site.

In order to avoid excessive EMC radiation, the DC potential must not vary rapidly to ground. Passive diode rectifiers on a grounded AC network are one solution to achieve this target. If active infeeds are used, the DC midpoint is connected to ground via capacitors, requiring an insulated AC transformer as a consequence. This solution is comparable to well-known IT AC networks, allowing operation even in case of fault of one DC rail to ground. In both cases, unshielded DC bus rails are expected to be suitable for proper EMC behavior.

For the rated DC link voltage, two possible dedicated values are defined. 540V will be used for uncontrolled rectifiers on 400V AC networks, allowing very simple DC network solutions. 650V will be used for both active infeed converters on 400V AC networks as well as for uncontrolled rectifiers operating on 480V AC networks. In both cases, loads will be disconnected below 400V dc and above 800V dc. Components may or may not contribute to the control of the DC link voltage, depending on their features. In a very simple solution, the DC link voltage is totally uncontrolled and just results from the operating point of all components connected. In a high sophisticated DC network, all components connected receive their setpoint value from a central network management. In between those two extremes, all solutions are possible.

The defined concept will be implemented on three different test sites. The development of high speed and low loss protection devices are expected to be the main challenge. First test results are expected to be available end of 2018.