Synchronization of two AC Auxiliary Converters without Communication Line

Graduate

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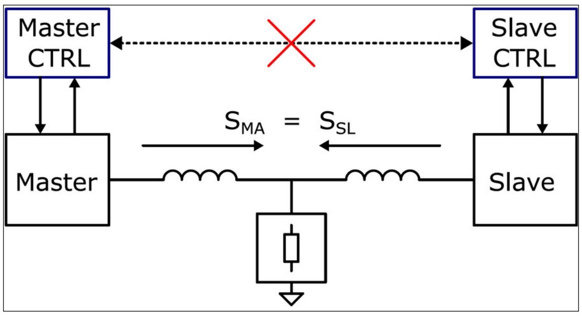
Introduction: The partner company is specialized in building rail vehicles such as streetcars. Various 3x400V/50Hz electrical components are used in these vehicles. To supply the electrical network, an islanded microgrid is created using so-called AC auxiliary converters. A typical setup for a streetcar includes two converters that independently supply about half of the rail vehicle, meaning that there are two different AC microgrids in one streetcar. A failure in one of the auxiliary converters will result in a disconnection, which will shut down half of the rail vehicle. To ensure stable operation in this scenario, a switch between the two microgrids can be closed, and the converter that is still working must supply the entire onboard AC grid. This requirement leads to a larger size of the converters.
To avoid shutting down the microgrids and to optimize the converter design, the partner company wants a single AC grid with synchronized converters. Since hardware changes are costly to implement, the solution should work without additional sensors or communication lines. Furthermore, it is desired that each converter supplies the same amount of power to the islanded microgrid.

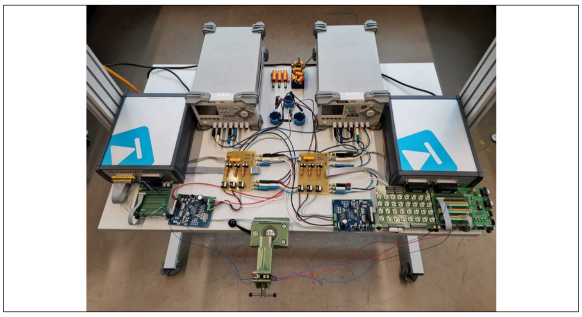
Approach: The objective of this thesis is to provide a strategy that synchronizes the two grids and can share the power between the two converters without additional sensors or communication lines. To achieve this, the droop control approach has been exploited. The key element of the proposed strategy is that the actual active and reactive power is shared between the converters by slightly varying the frequency and voltage amplitude of the three-phase AC system.

Conclusion: The droop control approach was successfully implemented on the downscaled hardware assembly. Synchronization and power sharing were demonstrated without additional hardware. Furthermore, different failure scenarios were investigated, and the system was made more robust by appropriate software optimizations. Finally, a simulation was performed, which showed that the work can be adapted to the needs of the partner company.

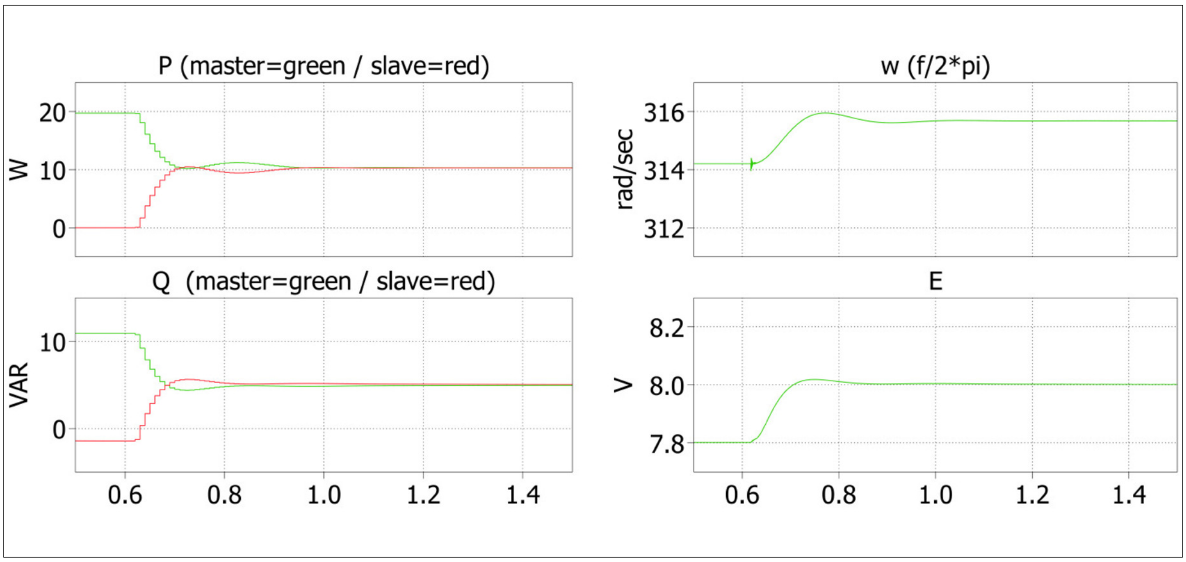
Block diagram to visualize the work done.
Own presentment



Downscaled hardware assembly to test the droop control approach.
Own presentment



Simulation results of the droop control strategy shown with the active and reactive power and the communication links.
Own presentment



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Subject Area
Electrical Engineering, Sensor, Actuator and Communication Systems

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