Model verification and common mode current analysis of a grid connected active filter

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Ideally, power would be transferred by the interaction of balanced and perfectly sinusoidal currents and voltages, in-phase with one another. However, power is not perfect. Disturbing currents in the grid affect connected electrical equipment. Shunt active filters are electronic devices designed to clean the currents. By using transistors in a smart way, shunt active filters inject currents in the grid that counteract the disturbances, resulting in almost perfect power transfer. However, this process creates its own minute disturbing currents, that should not enter the grid. To understand these minute currents created by the shunt active filter a simulation model that mimics the high frequency behavior has been developed.

Figure: *Illustration of the working principle of an active filter. Filtered signal to the right. Figure from Comsys ABs homepage.*

In this project, a model was made to simulate the high-frequency behavior of a shunt active filter from Comsys AB. The model can simulate the active filter (AF) adequately up to 2MHz. This was an increase in frequency from the previous model, that reached less than 200kHz.

All conducting materials have inherently present internal resistances and inductances. All conducting materials close to each other will have a capacitive coupling. These properties are called parasitic elements, and can be measured using an impedance analyser. Using the high resolution model, minute disturbing currents flowing through the parasites can be approximated. Common mode currents are disturbing currents that flow through the parasites to electrical ground. These were of certain interest in this study.

To construct the model, the individual components of the AF were measured with an impedance analyser. These measurements enabled modelling of the components' high frequency characteristics and include eventual parasites. An AF supplied by Comsys AB was set up in a lab environment and run to verify the simulation results. As with any other electronic equipment, AFs need to pass the requirements of electromagnetic compatibility (EMC) for it to be used and sold commercially. EMC-directives limit the radiated electromagnetic emissions and the conducted current emissions from the device. Common mode currents are one such sort of conducted current emissions.

The resulting model was able to simulate the AF up to 2MHz. Compared to the experimental measurements, the model was able to predict high frequency oscillations and common mode currents with reasonable accuracy. However, it was not enough with just measuring the individual components on their own to accurately represent the system. A fine tuning of the parasitic components was required, resulting in overall reasonable values, except for an unexpectedly high parasitic resistance of 70Ω. This will require further work to identify. This is an important step in further understanding AFs at higher frequencies.

In an increasingly electrified society EMC grows more and more important. To be able to lower the conducted current emissions from an AF, a simulation model is an incredibly helpful tool. Solutions on how to limit common mode currents impact can be investigated in a matter of hours instead of days or weeks.