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Perturbation Model Based Analysis of a Three Phase PWM ac-dc Power Converter

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Abstract

A three phase PWM ac-dc voltage source converter under phase and amplitude control is analysed using a steady state model and a small signal perturbation model. These models are verified against simulation of both the steady state behaviour and the transient response of the converter. A methodology is developed to compare the steady state model's results with those obtained from this and other similar small signal perturbation models. Using this technique, the step responses obtained from the small signal perturbation model are verified against results obtained from the steady state model. Mathematically obtained results show excellent agreement with simulation and experimental results.

The effect of circuit and control parameters on the steady state behaviour of the converter is determined and graphically presented. These results provide useful information in the initial design stages of the converter. The converter is a multiple input single output system. Small signal transfer functions relating the converter output to each of the input perturbations are determined and the step responses plotted for each case.

The effect of dc link capacitance on the transient response of the converter is investigated and presented. This is one parameter that has no effect on the low frequency steady state operation of the converter, but which strongly influences the small signal transfer functions. The effect of variation in this parameter on the small signal transfer function poles is presented as a root locus plot.

The effect of back emf on the zeros of the small signal transfer functions is investigated. Those regions of converter operation have been identified where the two transfer functions, which relate a change in dc link voltage to a perturbation in one of the two control inputs, are of the minimum or non-minimum phase type. This information provides crucial knowledge, not only about converter behaviour, but also for the controller design.