Intelligent controller for a 30 kV high-voltage module

Graduate

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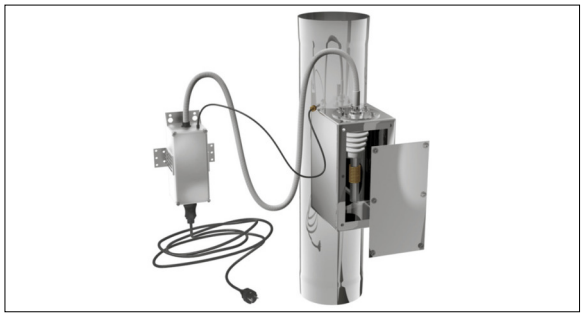
Introduction: Fine dust, especially particles with a diameter smaller than 10 µm, are harmful to health of humans and animals and must therefore be filtered out of exhaust gases. The use of the OekoTube from the company OekoSolve offers a promising solution to improve air quality and protect health. It is suitable for residential combustion stoves such as fireplaces or wood-burning stoves that use pellets, wood chips or firewood. The filter system uses the corona effect in the gas mixture. Due to the high voltage between the spray electrode and the collecting electrode, the smoke particles are ionised, accelerated in the electric field and settle on the cylinder wall. By preferentially using the negative corona, characterised by the negative potential of the DC voltage at the spray electrode, higher voltages and a greater current flow can be generated. This in turn increases the filter performance. The motivation of this bachelor thesis is to improve the high voltage control on its ripple and load jump behaviour employing an innovative concept, even in challenging operational conditions.

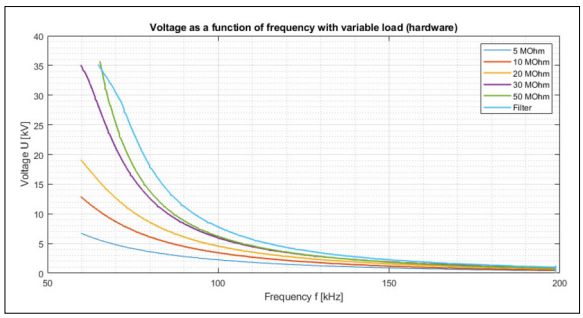
Problem: The central task of this project is to develop an optimised voltage control that ensures the stability of the operating voltage. Alternatively, a current control or current monitoring is to be worked out. Modelling and simulation of the high-voltage converter is part of the task and enables a fundamental analysis of the system characteristics. Based on the simulation results, hardware tests were carried out to investigate the behaviour of the system and to develop a control algorithm for a Digital Signal Processor (DSP).

Result: It turned out that the behaviour of the controlled system must be linearised so that the system operates stably and with the same control quality over the entire operating range. The nonlinear characteristic between the frequency as the manipulated variable and the voltage resp. current as the controlled variable was determined and for linearisation was multiplied by its inverse function. The analysis of the step response of the process shows first-order delay (PT_1) characteristic, its time constant varies only insignificantly despite changing load and different operating ranges.
In particular, the settling time of the voltage controller could be reduced significantly below the specified reference value, resulting in a faster response to load changes. The integration of current monitoring complements the voltage controller and enables a correction of deviations within predefined time span. Both the voltage controller and the current monitor have a low ripple of only a few bits, which underlines their stabilisation of the operating voltage and current respectively, and which now enables operation with a constant electric field.

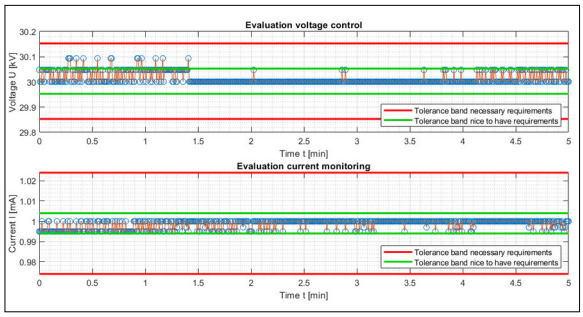
Structure of the OekoTube-Inside
Heizerschwaben Partikelabscheider



Voltage as a function of frequency with variable load
Own presentment



Separate evaluation of voltage control or current monitoring at a load of 30 MΩ
Own presentment



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Subject Area
Electronics and Control Engineering, Information and Communication Systems

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