Electronics drivers for high voltage dielectric electro active polymer (DEAP) applications

Dielectric electro active polymer (DEAP) can be used in actuation, sensing and energy harvesting applications, but driving the DEAP based actuators and generators has three main challenges from a power electronics standpoint, i.e. high voltage (around 2.5 kV), nonlinearity, and capacitive behavior. In this paper, electronics divers for heating valves, loud speakers, incremental motors, and energy harvesting are reviewed, studied and developed in accordance with their corresponding specifications. Due to the simplicity and low power capacity (below 10W), the reversible Fly-back converters with both magnetic and piezoelectric transformers are employed for the heating valve and incremental motor application, where only ON/OFF regulation is adopted for energy saving; as for DEAP based energy harvesting, the non-isolated Buck/Boost converter is used, due to the system high power capacity (above 100W), but the voltage balancing across the series-connected high voltage IGBTs is a critical issue and accordingly a novel gate driver circuitry is proposed and equipped; due to the requirements of the audio products, such as low distortion and noise, the multi-level Buck converter based Class-D amplifier, because of its high control linearity, is implemented for the loud speaker application s. A synthesis among those converter topologies and control techniques is given; therefore, for those DEAP based applications, their diversity and similarity of electronics drivers, as well as the key technologies employed are analyzed. Therefore a whole picture of how to choose the proper topologies can be revealed. Finally, the design guidelines in order to achieve high efficiency and reliability are discussed.

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