

Single Chip Controller Design for Piezoelectric Actuators with Mixed Signal FPGA

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Abstract : The piezoelectric material is being used widely for actuators due to its large power density with simple structure. It can generate a larger force than the conventional actuators with the same size. Furthermore, the response time of piezoelectric actuators is very short, and thus, it can be used for very fast system applications with compact size. To control the piezoelectric actuator, we need analog signal conditioning circuits as well as digital microcontrollers. Conventional microcontrollers are not equipped with analog parts and thus the control system becomes bulky compared with the small size of the piezoelectric devices. To overcome these weaknesses, we are developing one-chip micro controller that can handle analog and digital signals simultaneously using mixed signal FPGA technology. We used the SmartFusion™ FPGA device that integrates ARM®Cortex-M3, analog interface and FPGA fabric in a single chip and offering full customization. It gives more flexibility than traditional fixed-function microcontrollers with the excessive cost of soft processor cores on traditional FPGAs. In this paper we introduce the design of single chip controller using mixed signal FPGA, SmartFusion™[1] device. To demonstrate its performance, we implemented a PI controller for power driving circuit and a 5th order H-infinity controller for the system with piezoelectric actuator in the FPGA fabric. We also demonstrated the regulation of a power output and the operation speed of a 5th order H-infinity controller.

Keywords : mixed signal FPGA, PI control, piezoelectric actuator, SmartFusion™

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