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Design of DC-DC Buck Converter for Smartphone Applications Based on FPGA Digital Voltage Controller

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Abstract— *This paper presents an enhancement of the output performance of a linear buck converter system for the mobile (smartphone) devices using an adaptive digital Proportional–Integral–Derivative (PID) controller with off-line swarm optimization algorithm. The work focuses on improving the use of using single-input single-output (SISO) digital Field Programmable Gate Array (FPGA)-PID to control the linear buck converter system. The goal of the proposed adaptive SISO-FPGA-PID voltage-tracking controller is to rapidly and precisely identify the optimal voltage control action (optimal on-off duration time) that is used to control the buck converter output voltage level in order to avoid the troubleshooting hardware problem issues on mobile devices. The Particle Swarm Optimization (PSO) algorithms are used to find and tune the three weights of the SISO-FPGA-PID controller. The numerical simulation results and the experimental work using Spartan-3E xc3s500e-4fg320 board with Verilog hardware description language (HDL) show that the proposed controller is more accurate in terms of voltage error and the number of function evolutions are of high reduction. As well as to generate a smooth voltage control response without voltage oscillation in the output by investigating under mobile applications variations such as using Bluetooth, WI-FI, and CPU operating voltage when these results are compared with other controllers.*

Index Terms— *Buck Converter System; Adaptive SISO-FPGA-PID Controller; Off-Line Particle Swarm Optimization.*

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