

NON-INVASIVE DC-DC BUCK CONVERTER LOAD CURRENT ESTIMATION TECHNIQUE FOR EMBEDDED SOFTWARE POWER ESTIMATION

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ABSTRACT

The objective of the research was to achieve a non-invasive, DC-DC buck converter load current estimation technique in embedded systems. Buck converters supply power to the processor and peripherals in an embedded system. The DC supply voltage is specified and the power is dependent on the current consumed. The current consumed by the processor and peripherals is dependent on the embedded software. Hence, estimation of buck converter load current is required for embedded software power estimation and optimisation.

Current sensing techniques that exist for this purpose are invasive and require modification of hardware. A non-invasive technique to determine buck converter load current was developed in this work. A model for steady-state load current and dynamic load current was derived. The steady-state model formed the basis of the current estimation technique. The model applies Ohm's law across the inductor in the buck converter to compute the DC current. The inputs of the model are the inductor DC resistance (DCR) and the DC components of the voltages across the inductor. This includes the DC component of the switch-node voltage which is a fast-switching voltage. A low-pass filter was justified and incorporated into the technique to provide an analogue average of the switch-node voltage.

Simulations were conducted to validate the current estimation technique. Experimental characterisation and validation of the technique was conducted on a power supply module where the load resistance and current were known. The technique was applied to a dynamic load and the technique estimated the waveform of a switching DC load current with an overall error of the average current of approximately 6 %. It was shown to be applicable for use in the software power optimisation processes. The current estimation technique was tested on a single board computer and current estimation results were obtained for ten seconds of software execution for three test cases. The results of the current estimation were as expected, based on the type of software operations performed in the test cases.

This work did not include the temperature dependence of the DCR of the inductor. For future work, the effect of DCR temperature drift can be included in the model. Furthermore, automation of the data capturing process and measurement technique can be developed.