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High Reliability DC/DC Converter Module for Electronic Boards Equipped with FPGAs

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A high reliability Buck DC/DC converter, ready to be used on several CERN electronic boards equipped with FPGAs, has been designed and verified. Long lifetime design, according to CERN requirements, has been implemented by minimising component stress with 50% derating. It is a compact power supply module of 16 x 19 mm, which can deliver up to 6A with 95% efficiency.
Its main features include an input range from 3.0V to 5.5V, output range from 0.6V to 3.3V, shielded inductor, output ripple below ±50mVpp, soft-start and thermal shutdown.

Summary

The Beam Instrumentation Group at CERN is designing a new general-purpose VME carrier module utilising several PTH04T230W DC/DC converters. These off-the-shelf converters are built with unshielded inductors and need to be mounted on the printed circuit board as stand-alone components. Thus, reducing the global manageability and increasing the total cost of the carrier module. The new design aims to develop a module with better power dissipation, efficiency and reliability. In the future, it should be also possible to be directly integrated on the mainboard. For this reason, a Buck DC/DC converter has been implemented with the following main characteristics: input range from 3.0V to 5.5V; output range from 0.6V to 3.3V, settable by means of an external resistor; output current protection at 6A; maximum output ripple ±50mVpp; switching frequency of 300KHz; short circuit protection; On/Off function; EMI reduction with frequency spread spectrum; soft-start function and thermal shutdown, in a 16 x 19 mm compact size.
The selected buck controller is the TPS40303 integrated circuit and drives the CSD16321 power MOSFET, both from Texas Instruments. All selected components have been used at a minimum derating of 50% to reduce component stress and increase the reliability of this module. The selected inductors, i.e. Bourns SRP1055, are the main contributor for the high efficiency (95%), due to their very low equivalent series resistance.
On the 4-layer PCB comprising all the component of this module, a snubber circuit, for further reduction of the output ripple due to the MOSFET ringing, can be mounted optionally. It is left as an option due to its effect on the total efficiency. The board layout has been optimized for maximum heat transfer and it can be used without active cooling. The board can maintain the maximum temperature on its surface, while at maximum current output, below 55℃ at 25℃ ambient temperature.
An example of the electrical performance simulation, as well as the verification methodology and the test bench realised will be shown.

Primary author: VIGANO, William (CERN)

Co-authors: BOCCARDI, Andrea (CERN); Dr ZAMANTZAS, Christos (CERN)

Presenter: SIRVENT BLASCO, Jose Luis (University of Barcelona (ES))

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