UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Unitat de Valorització

UNIVERSITAT ROVIRA I VIRGILI

A voltage-sensing circuit structure to enhanced fast-scale stability margin of a switching power converter

A voltage-sensing circuit structure for a switching power converter and a method for an enhanced fast-scale stability margin of a switching power converter have been developed and patented. Partners to further develop the system and/or to establish commercial agreements along with technical cooperation are sought.

The Challenge

A main bottleneck precluding the on-chip integration of a switching power converter for energy management purposes is the large area of the reactive components, the resulting high output ripples and the tendency to exhibit fast-scale instabilities. Through a compact IC-suitable circuit, the presented innovation extends the design space by concurrently decreasing the size of reactive components, decreasing the output power ripple and moving away the border of fast-scale instability, thereby better fitting the stringent specifications of on-chip switching power converters.

The Technology

The technology is based on a simple technique which narrowband amplifies the switching frequency component in the converter feedback loop aiming to improve the fast-scale stability boundary of power management switching converters. This boundary has been recently related to the capability of achieving further miniaturization of the reactive power components or low switching frequency (higher efficiency) converters without losing stability. The technology has been further developed into a preferred embodiment as a compact circuit, which concurrently improves the controllability of fast-scale chaotic instabilities, thereby allowing reducing volume or increasing efficiency, without losing stability. At the same time, the circuit reduces the output power ripple. This technology is instrumental to miniaturization and on-chip integration of power converters. The technique can be applied to voltage-mode or current-mode PWM feedback, avoiding the use of external ramp. The circuital structure is based on a simple inductor-capacitor circuit set implementing a notch selective narrowband filter in the power path centered at the switching frequency, while providing an output ripple rejection. The benchmarked benefits of the circuit have been proved even for low quality factor inductor and capacitor, although better performance is obtained if higher quality factor are technologically feasible. The impact of this additional circuit upon other kinds of instabilities such as slow-scale or Hopf bifurcations (typically predicted by dynamics averaged models) is very small.

Innovative advantages

- Innovative technique for controlling fast-scale instability based on narrowband amplifying the harmonic at the switching frequency. While prior art techniques were based on delay-cell-based complex circuits (and analysis), this technique is based on a simple circuit and it can be described and designed by means of a frequency domain analysis.
- Simple and compact circuit, easily implementable and on-chip amenable, that tackles the control of fast-scale instabilities while concurrently providing output power ripple reduction, thereby extending the design space to better fit typical specifications of on-chip switching power converters. The simplicity of the circuit compared to previous proposed topologies facilitates its potential implementation in an integrated power management IC.

Current stage of development

An experimental prototype has been obtained, demonstrating the advantage of the technique in reducing either the required silicon area or volume of the passive components, or the switching frequency and in turn decreasing switching losses while concurrently reducing the output ripple of the converter and avoiding fast-scale instability.

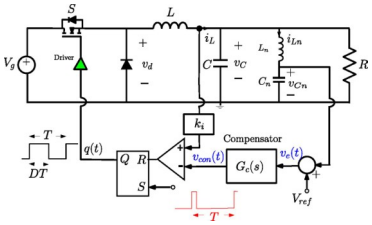
Applications and Target Market

The patent can be applied to products requiring power management DC-DC conversion with special interest in miniaturized low form factor and high-efficiency applications, such as battery-operated portable device applications and energy harvesters.
Target Market is power management IC manufacturers or consumer electronics companies on portable devices.

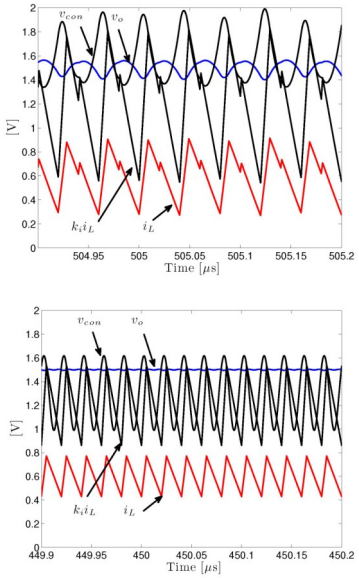
Reference number

MKT2011/0060_I

Innovative technique for controlling fast-scale instability



CMC buck converter by sensing the output voltage ripple through an LC divider



Time-domain waveforms of the state variables in a CMC buck converter without (top) and with (bottom)LC divider chaos controller. Stability is observed without uisng compensating ramp and output voltage ripple is reduced

Business Opportunity

Technology available for licensing with technical cooperation

Patent Status

PCT application

Contact

Mr. Xavier Estaran Latorre
Licensing Manager
T. + 34 934 134 094
M. +34 626 260 596
f.xavier.estaran@upc.edu

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