A Current-mode DC-DC Converter using a Quadratic Slope Compensation Scheme

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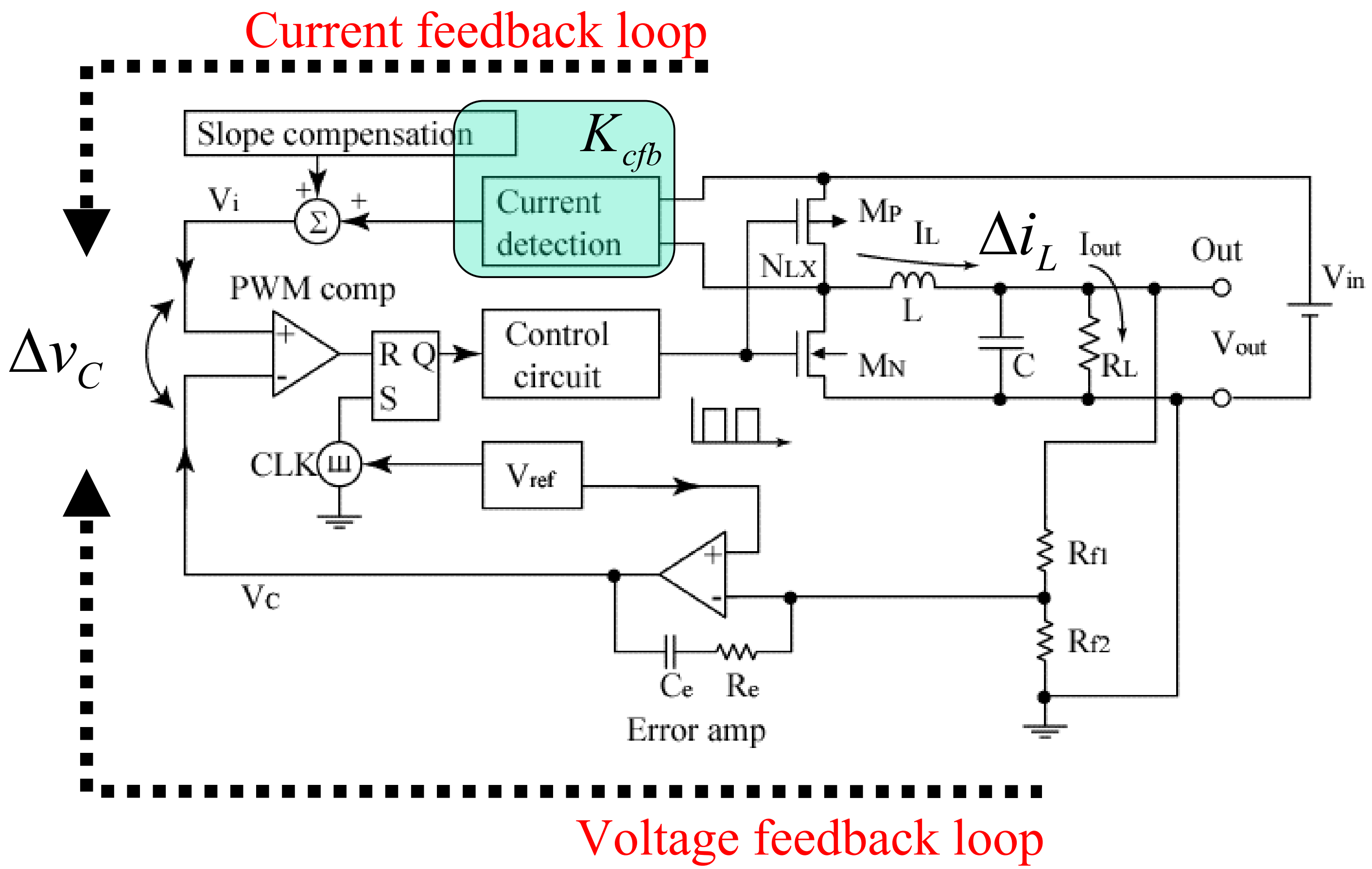
Block diagram of a current-mode, MOS, buck DC-DC converter



The slope compensation must be applied to the current feedback loop.

Conventional slope compensation and the damping factor

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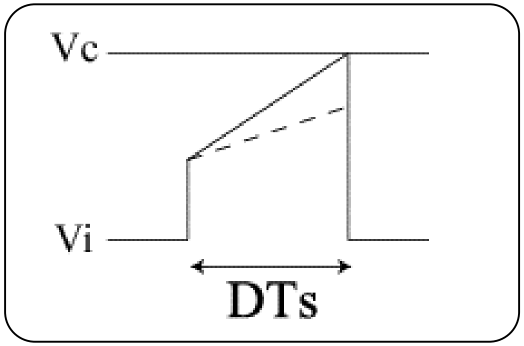
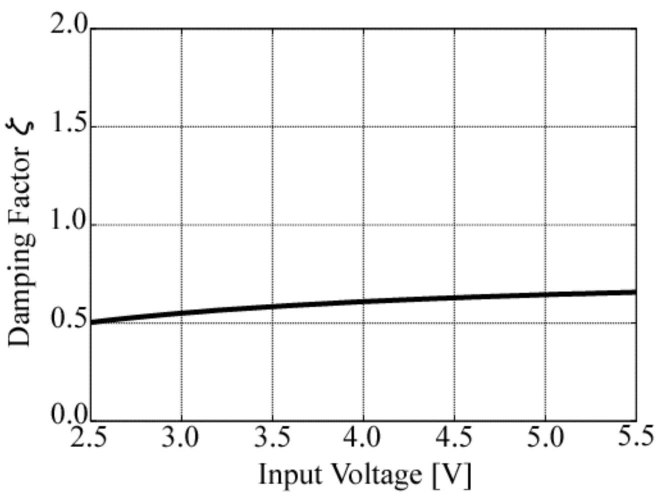
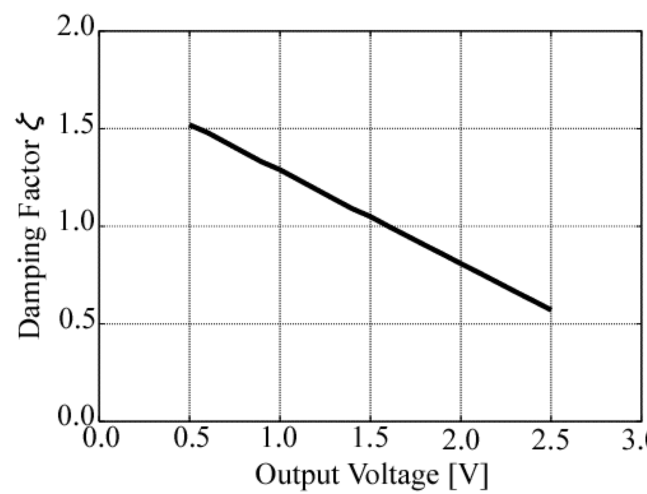


A linear slope is the standard.



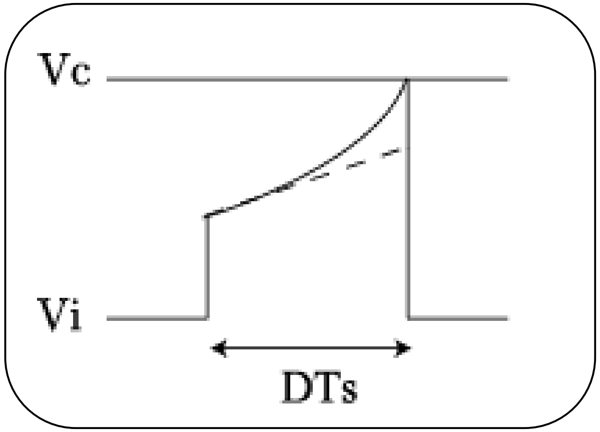


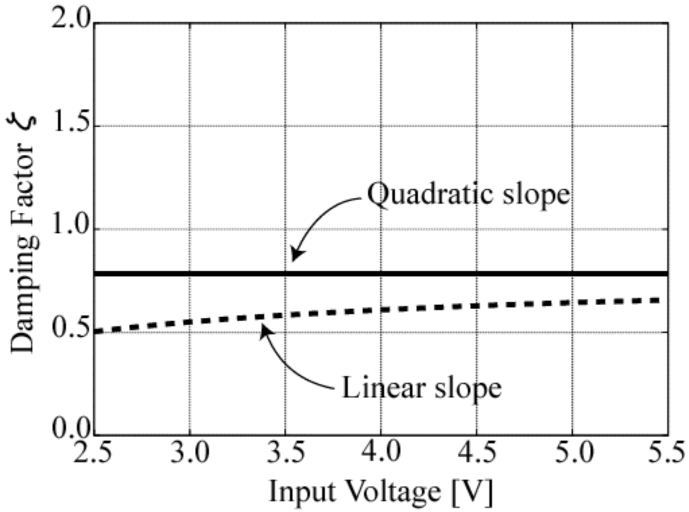
However, the damping factor ζ becomes dependent on Vin and Vout.

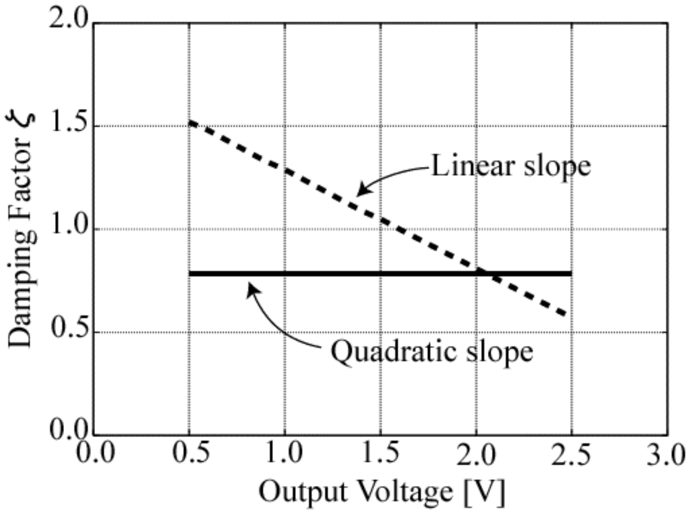
The proposed quadratic slope and its damping factor

$$\zeta = \frac{\pi}{2}\left(\frac{1}{2} + \frac{2LD}{V_{in}K_{cfb}f_x}m_c - \frac{V_{out}}{V_{in}}\right)$$

$$m_c = \frac{V_{in}K_{cfb}f_s}{2L} \quad -> \quad \zeta = \frac{\pi}{4} = 0.8(const.)$$







Yes, we can have the damping factor ζ independent of Vin and Vout.

Experimental results

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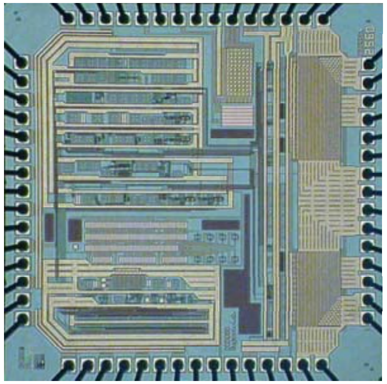
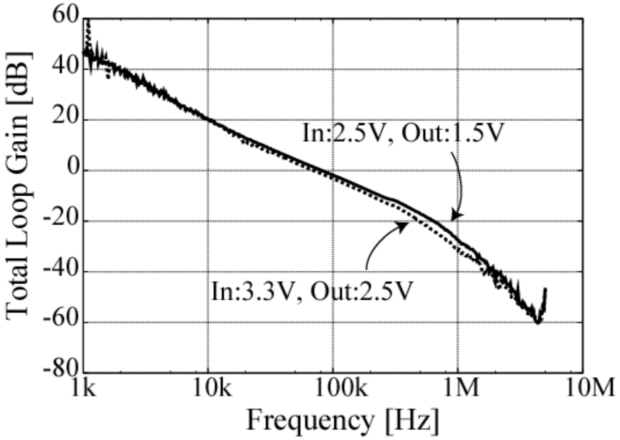


Table 1. Overall chip performance

Input voltage	3.3V ~ 2.5V
Output voltage	2.5V ~ 0.5V
Max. load current	500mA
Process	0.35um CMOS



The constant frequency characteristics were obtained.

The VLSI chip in this study has been fabricated in the chip fabrication program of VLSI Design and Education Center(VDEC), the University of Tokyo in collaboration with Rohm Corporation and Toppan Printing Corporation.

Conclusion

1. A quadratic slope compensation scheme was proposed.

2. The quadratic slope realized that the damping factor and the frequency characteristics of the current feedback loop were constant.

3. A test chip of a current-mode DC-DC converter verified the effect of the quadratic slope.