

# Transfer Functions of Switching Converters: Fast Analytical Techniques at Work with Small-Signal – 1<sup>st</sup> print

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Corrections of typos, mistakes and errors found by readers or by the author himself.

**Page 3:** figure 1.3 caption: you *perturb* a system...

**Page 19:** in the middle of the Figure 1.26, below the blue arrow, the symbol for  $\ll$  has disappeared during the print and was replaced by blank space:  $\Delta V \ll V$

**Page 21:** the off-time slope in the buck is negative of course and (1.48) could be misleading as it considers the downslope to be  $V_{out}/L$  as commonly expressed. If we consider a negative slope as in (1.45), then the (1.48) should be written as

$$I_{valley} = I_{peak} + S_{off} t_{off} = I_{peak} - \frac{V_{out}}{L} t_{off} \quad (1.48)$$

**Page 21:** the way I marked the inductor voltage in Figure 1.27 has generated some confusion. The + and – signs indicate the inductor polarity, how the voltage across its terminals is measured if you want. The voltage across this element obviously changes from  $t_{on}$  to  $t_{off}$  but the drawing could induce confusion. I therefore redrawn it below in a hopefully clearer way:

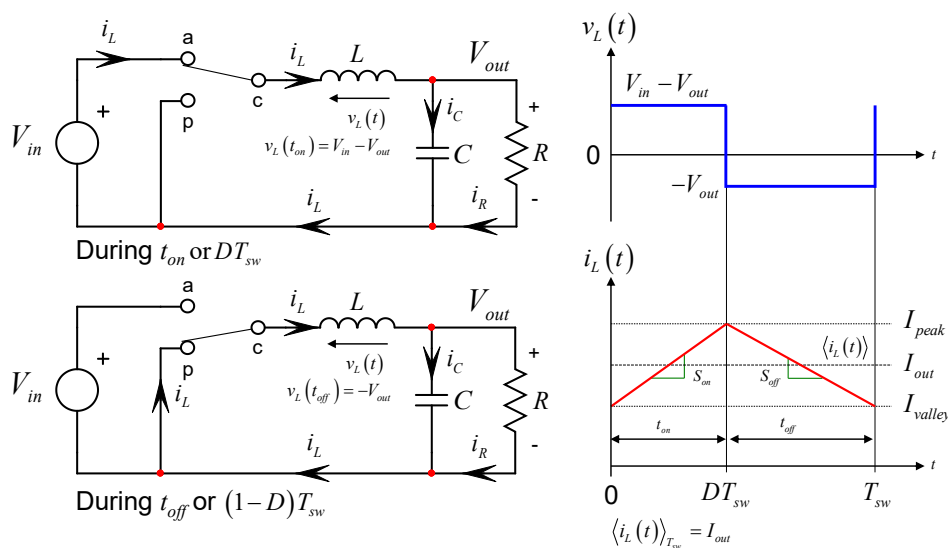


Figure 1.27

**Page 27:** the way I marked the inductor voltage in Figure 1.31 has generated some confusion. The + and – signs indicate the inductor polarity, how the voltage across its terminals is measured if you want. The voltage across this element obviously changes from  $t_{on}$  to  $t_{off}$  but the drawing could induce confusion. I therefore redrawn it below in a hopefully clearer way:

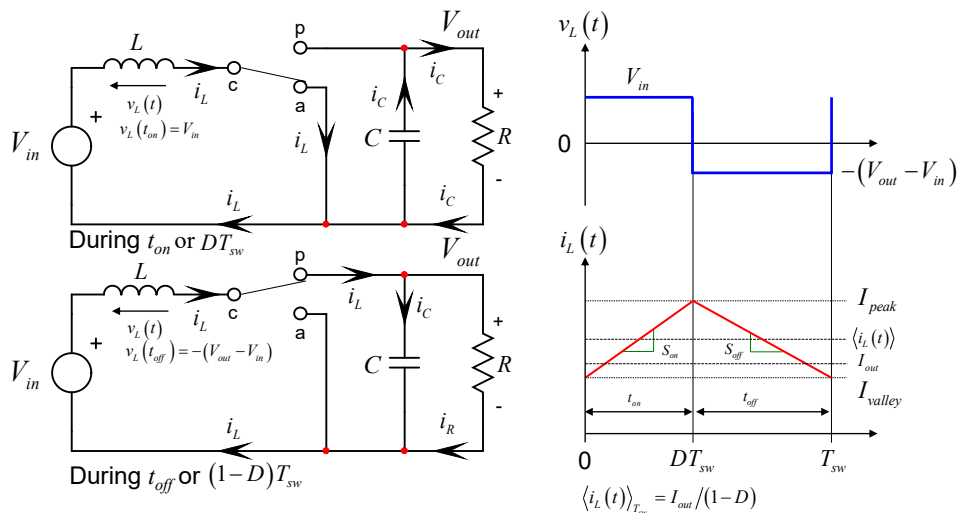
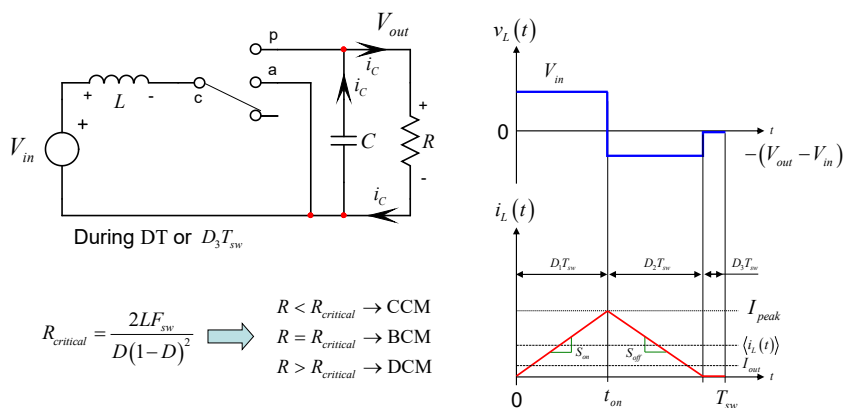


Figure 1.31

**Page 28:** below the two upper bullets: ...the on-time to *supply*...

**Page 28:** Figure 1.33: the labels *a* and *p* are swapped. *p* goes to the *RC* network while *a* goes to ground.



**Page 29:** figure 1.34 caption: ...converter *illustrates*...

**Page 35:** bottom of the page, last sentence: ... no net change in the inductor *voltage* across...

**Page 36:** the way I marked the inductor voltage in Figure 1.36 has generated some confusion. The + and - signs indicate the inductor polarity, how the voltage across its terminals is measured if you want. The voltage across this element obviously changes from  $t_{on}$  to  $t_{off}$  but the drawing could induce confusion. I therefore redrawn it below in a hopefully clearer way:

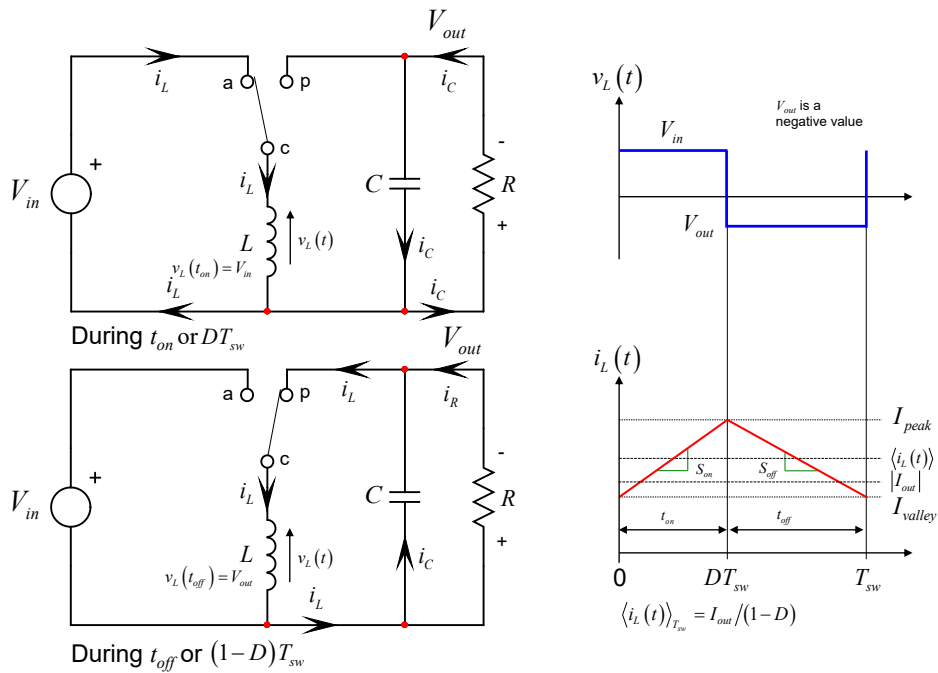
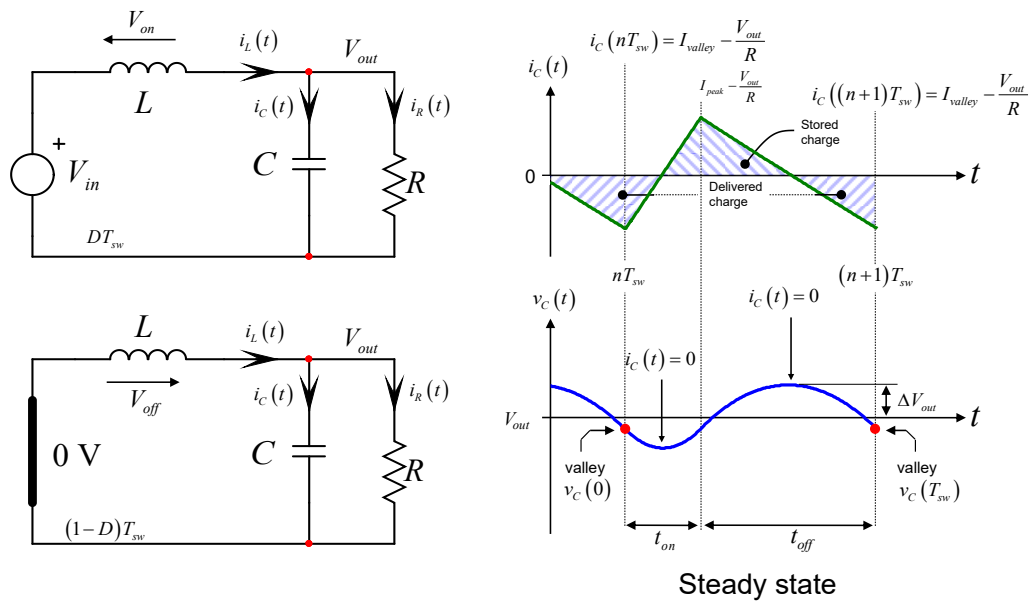


Figure 1.36

**Page 40:** figure 1.45, the inductor voltage arrow should point right since the left node is grounded and the voltage across the capacitor is positive:



**Page 41:** in equation (1.91),  $V_{out}$  is negative meaning

$$V_{in}DT_{sw} = -V_{out}(1-D)T_{sw} \quad (1.91) \text{ leading to}$$

$$M = -\frac{D}{1-D} \quad (1.92)$$

**Page 64:** in equation (1.150), this is  $i_L(t)$  in the denominator:

$$R_{eq} = \frac{v_{CS}(t)}{i_L(t)} = R_{sense} G$$

**Page 70:** under (1.168): ...because ~~of~~ a lot...

**Page 85:** under (1.191): ...during  $t_{on}$  is  $V_{in} - V_{out}$ .

**Page 107:** typo below (1.276): *Once* last comment... One last comment...

**Page 111:** in (1.282), the minus sign has disappeared from the denominator:

$$Q = \frac{1}{\pi[m_c(1-D) - 0.5]}$$

**Page 147:** 2<sup>nd</sup> paragraph, below equation (2.24), Set node  $d$  to 0 in *Figure 2.3* and source  $B_2$  becomes 0 V (a short circuit).

**Page 189:** typo in *Figure 2-79* caption: the circuit *hosts* three energy-storing...

**Page 201:** in the text, above *Figure 2.98*, I mention  $-31$  dB in an uncompensated version but it is  $-21.6$  dB: ...goes from  $-21.6$  dB in an uncompensated version...

**Page 213:** *figure 2.114* caption: ...a Mathcad<sup>®</sup> *sheet* helps...

**Page 214:** Top of the page, second line: We replace *the* buck CCM...by its DCM ~~the~~ small-signal...

**Page 223:** equation (2.333), a “+” sign was mistakenly replaced by a “-” for the term  $k_5 V_{in}$ :

$$V_{out} = k_2 V_{in} - k_2 V_{out} + k_3 \frac{V_{out}}{R_{load}} + k_4 V_{in} + k_5 V_{in} - k_5 V_{out} \quad (2.333)$$

**Page 257:** *Figure 2.176* caption should be “SIMPLIS confirms the peaking is located at 3.2 kHz as predicted by the calculated resonant frequency”

**Page 268:** Bottom of the page, “The summary of the control-to-output transfer functions of the forward converter operated in current mode *appears* in *Figure 2.192*”.

**Page 317:** I made a wrong simplification to obtain equation (3.98) and the first term in the resistance expression is simply  $r_C$ :

$$\tau_2 = \frac{V_T}{I_T} C_2 = C_2 \left[ r_C + \frac{r_L(1+k_6) - k_5}{1 - \frac{k_5}{R_{load}} + \frac{r_L}{R_{load}}(1+k_6) - k_4 + k_2 r_L(1-k_4)} \right]$$

The change needs to be propagated to (3.99) and (3.101)

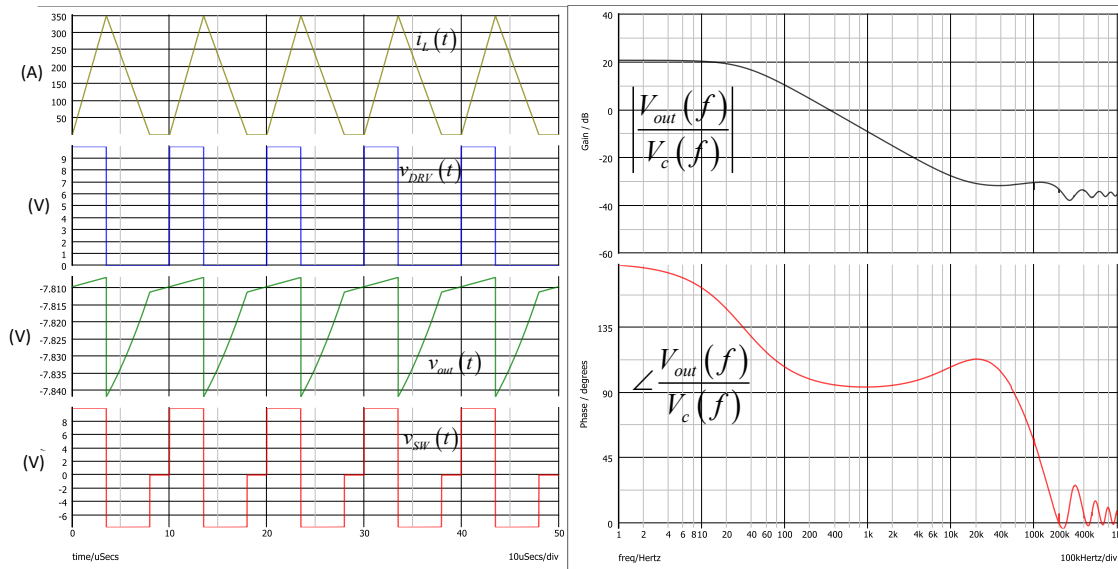
**Page 446:** the source in the left side of *Figure 4.6* should be  $I_c D(s) + I_c(s) D_0$

**Page 481:** there is no mistake in expression (4.132) but it simplifies to  $R_0 = \frac{R_L}{2}$

**Page 481:** in (4.133), the  $s$  is obviously missing and you should read  $Z_1(s) = r_c + \frac{1}{sC_2}$ .

**Page 483:** (4.138) is wrong and it should be (4.132) or  $R_0 = \frac{R_L}{2}$ .

**Page 548:** figure 4.131 figure. For a reason that I ignore, the magnitude plot has been truncated:



**Page 571:** in Figure 4.158, the formula for  $M$  is correct but the definition for tau is missing the turns ratio square:  $\tau_L = \frac{L_p N^2}{R_{load}} F_{sw}$  while it correctly appears in the Mathcad sheet of Figure 4.159.

**Page 580:** the transfer function in Figure 4.169 features a wrong subharmonic term and

should be corrected in the left side of the picture: 
$$H_0 \frac{\left(1 + \frac{s}{\omega_{z_1}}\right) \left(1 - \frac{s}{\omega_{z_2}}\right)}{\left(1 + \frac{s}{\omega_{p_1}}\right) \left(1 + \frac{s}{\omega_n Q_p} + \left(\frac{s}{\omega_n}\right)^2\right)}$$

**Page 626:** below equation (5.74) and in the text, then below (5.78): **Error! Reference source not found.** It should be: ...defined in (5.72). ...to the factorization in (5.71). ...raw numerator of (5.62).

**Page 679:** I incorrectly considered the two resistances in parallel while they are obviously in series in Figure 16:

...from  $L_1$ 's terminals is  $r_l + R_2$

$$\tau_1 = \frac{L_1}{r_l + R_2} \quad (\text{A.34})$$

$$\omega_p = \frac{r_L + R_2}{L_1} \quad (\text{A.36})$$

$$Z_{in}(s) = [R_1 \parallel r_L \parallel R_2] \frac{1 + s \frac{L_1}{r_L + R_1 \parallel R_2}}{1 + s \frac{L_1}{r_L + R_2}} = R_0 \frac{1 + \frac{s}{\omega_z}}{1 + \frac{s}{\omega_p}} \quad (\text{A.37})$$

$$\omega_p = \frac{r_L + R_2}{L_1} \quad (\text{A.38})$$

**Page 683:** above equation (A.45), page 683, the *numerator*  $N(s)$  is thus expressed as...

**Page 685:** the bullet for my book on transfer functions should be 4. but it has disappeared:

4. C. Basso, *Linear Circuit Transfer Functions – An Introduction to Fast Analytical Techniques*, Wiley, 2016.
5. D. Feucht, *Design-Oriented Circuit Dynamics*, <http://www.edn.com/electronics-blogs/outside-the-box-/4404226/Design-oriented-circuit-dynamics>
6. D. Peter, *We Can do Better: A Proven, Intuitive, Efficient and Practical Design-Oriented Circuit Analysis Paradigm is Available, so why aren't we using it to teach our Students?*, [http://www.icee.usm.edu/ICEE/conferences/asee2007/papers/1362\\_WE\\_CAN\\_DO\\_BETTER\\_A\\_PROVEN\\_INTUITIVE\\_E.pdf](http://www.icee.usm.edu/ICEE/conferences/asee2007/papers/1362_WE_CAN_DO_BETTER_A_PROVEN_INTUITIVE_E.pdf)

**Page 666:** the word Figure 1 is incorrectly repeated twice in the middle of the page.