Transfer Functions of Switching Converters: Fast Analytical Techniques at Work with Small-Signal – 1st print

Christophe Basso – May 2021
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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 << has disappeared during the print and was replaced by blank space: $\Delta V << V$

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

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

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:

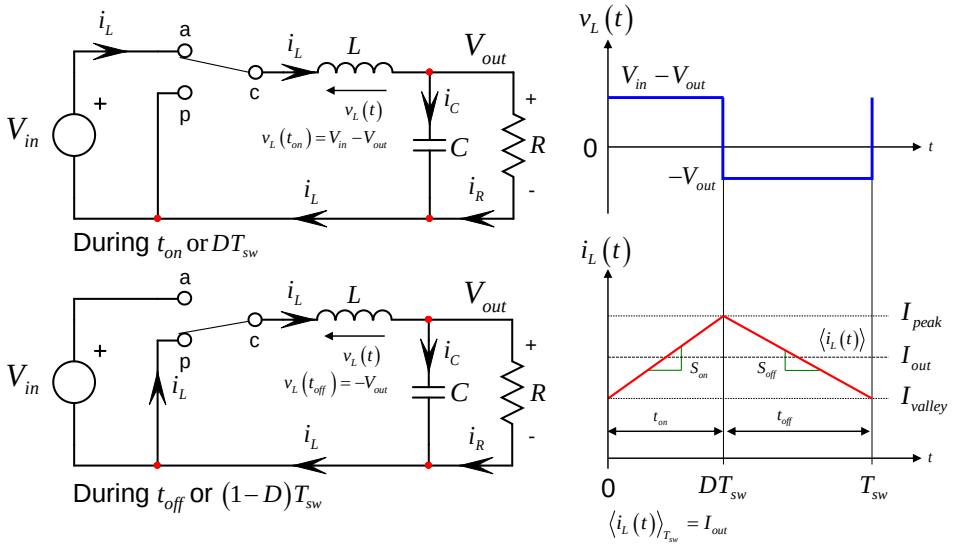


Figure 1.27

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:

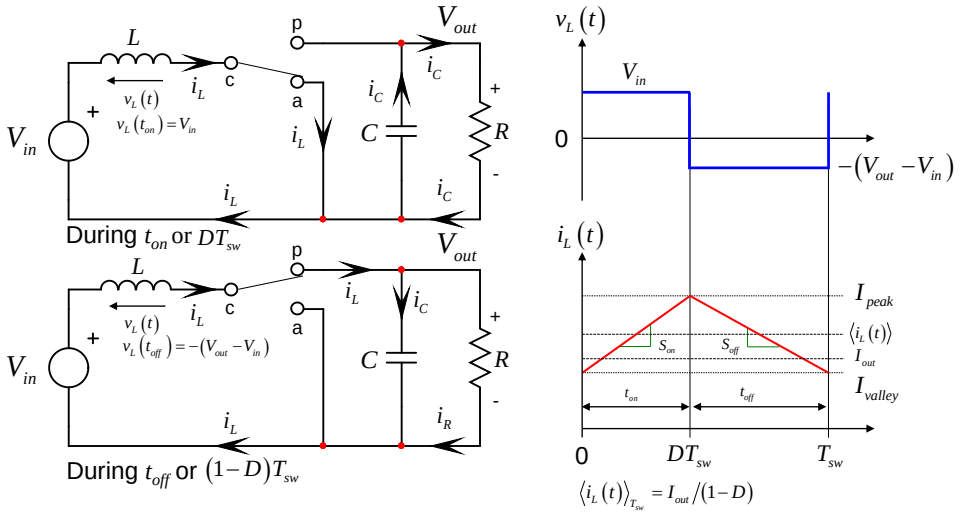
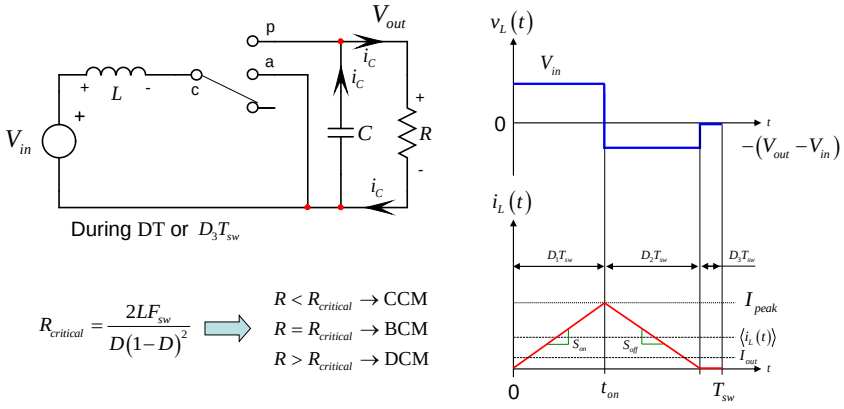


Figure 1.31

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:

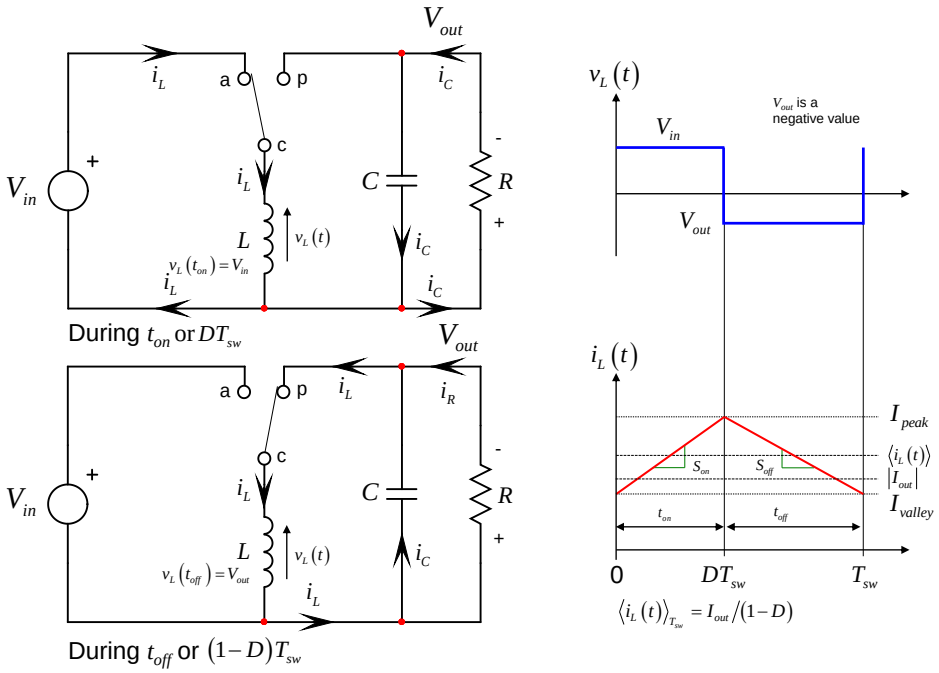
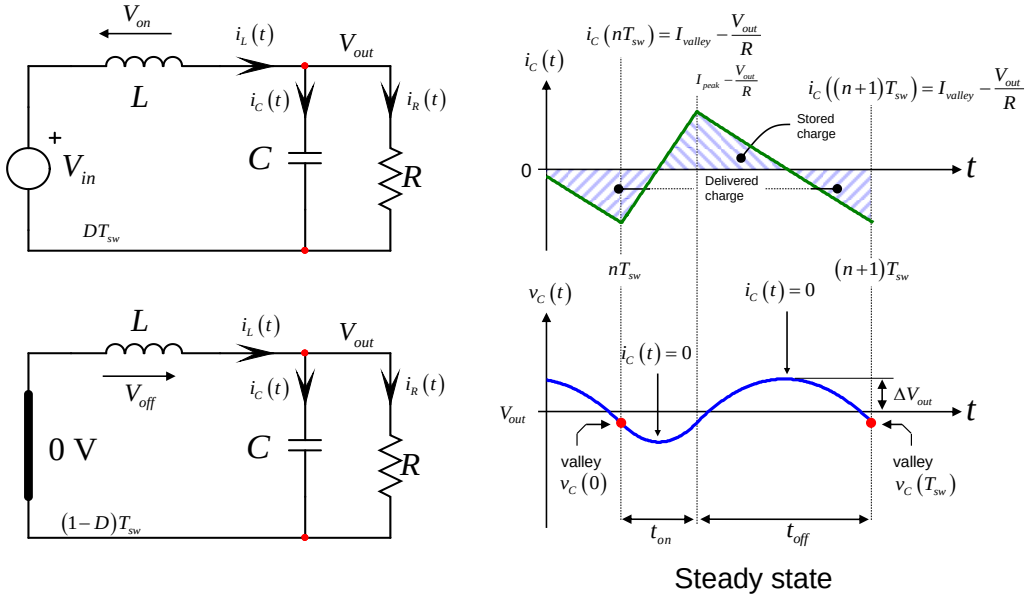


Figure 1.36

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

$V_{in}DT_{sw} = -V_{out}(1-D)T_{sw}$ (1.91) 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 147: 2nd 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® *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 $k_5 V_{in}$:

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

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:

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

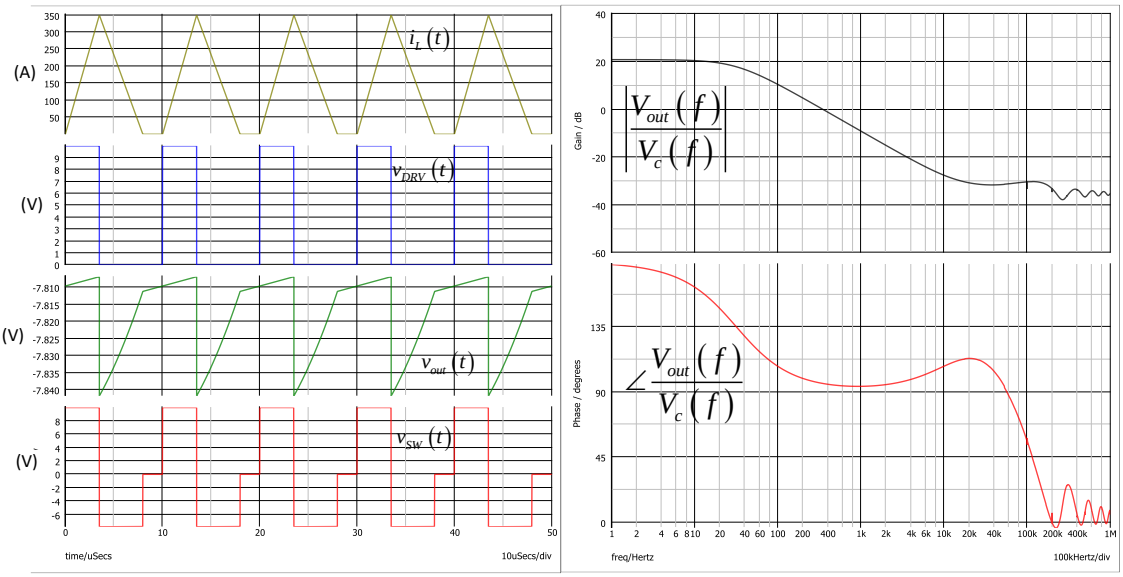
The change needs to be propagated to (3.99) and (3.101)

Page 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 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 $r_L + R_2$

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

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

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

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

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

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