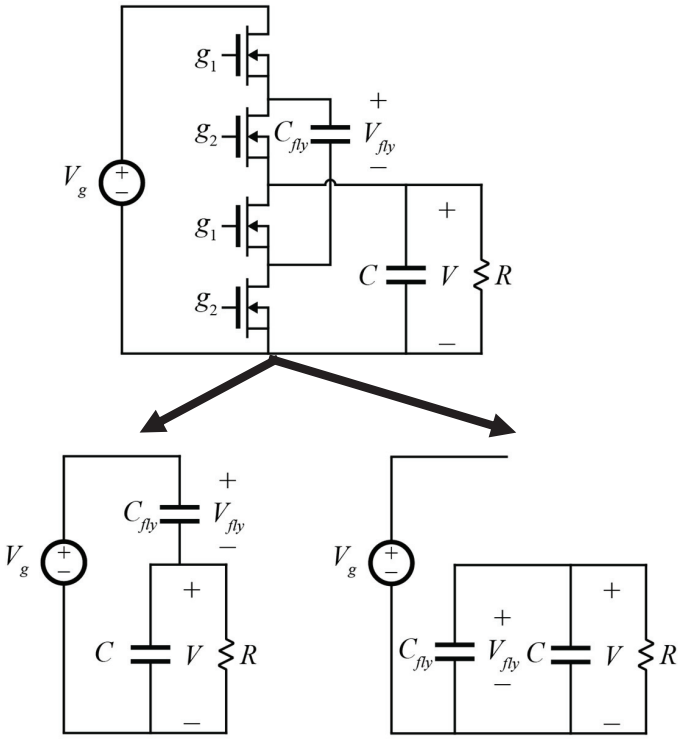
2:1 Converter Charge Vector Analysis



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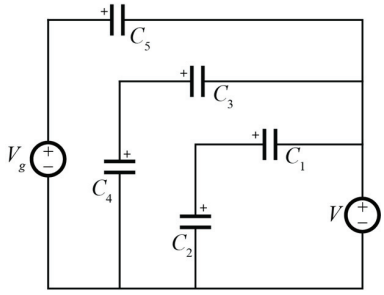
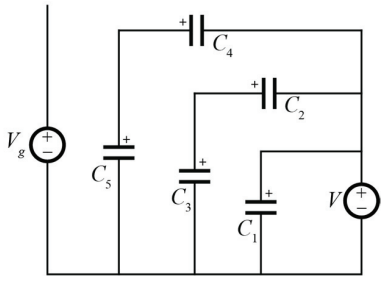
Dickson Charge Vector Analysis





Charge Vector Analysis in FSL

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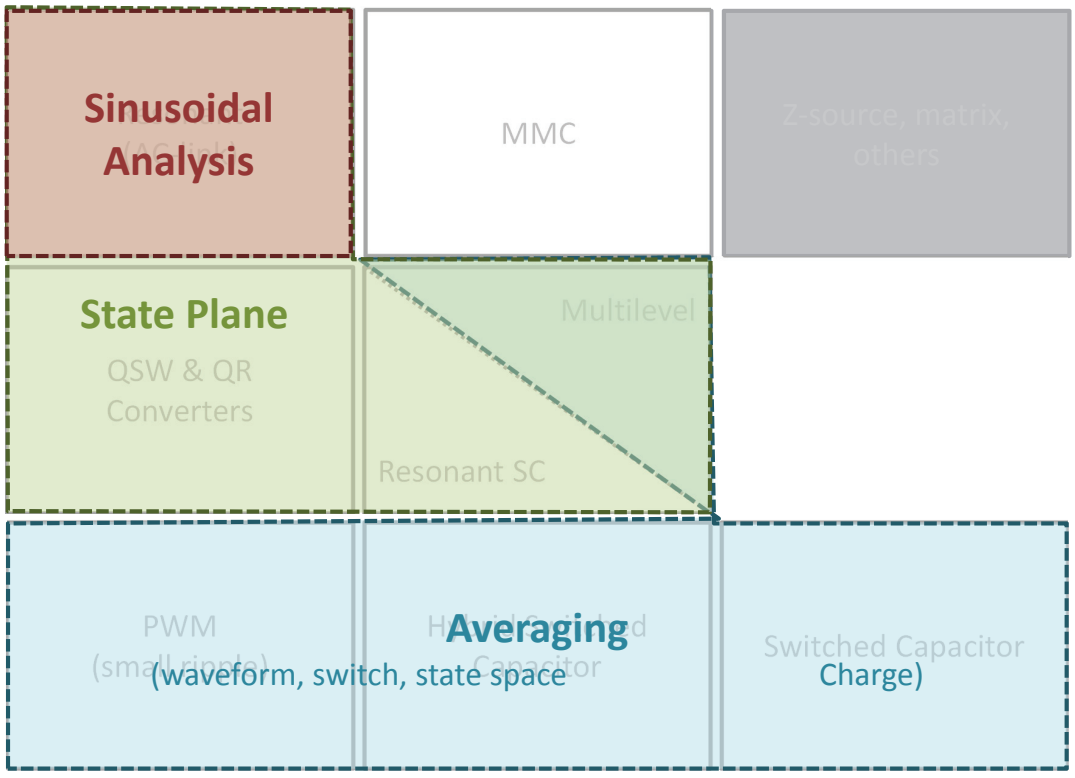
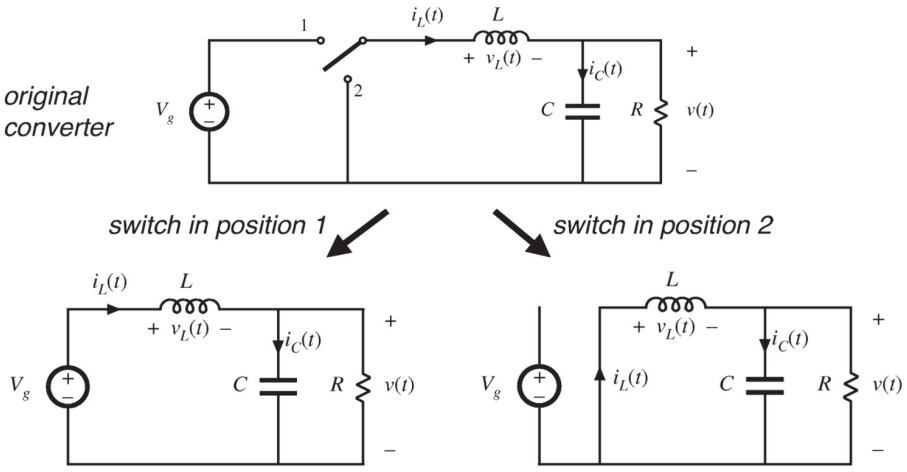
DISCRETE TIME MODELING

Converter Analysis



Switched Circuits



Historical Perspective

Robert D Middlebrook
PhD, Standford, 1955
CalTech Professor, 1955-1998

Slobodan Cúk
PhD CalTech, 1976
CalTech Prof, 1977-1999

Modelling, analysis, and design of switching converters

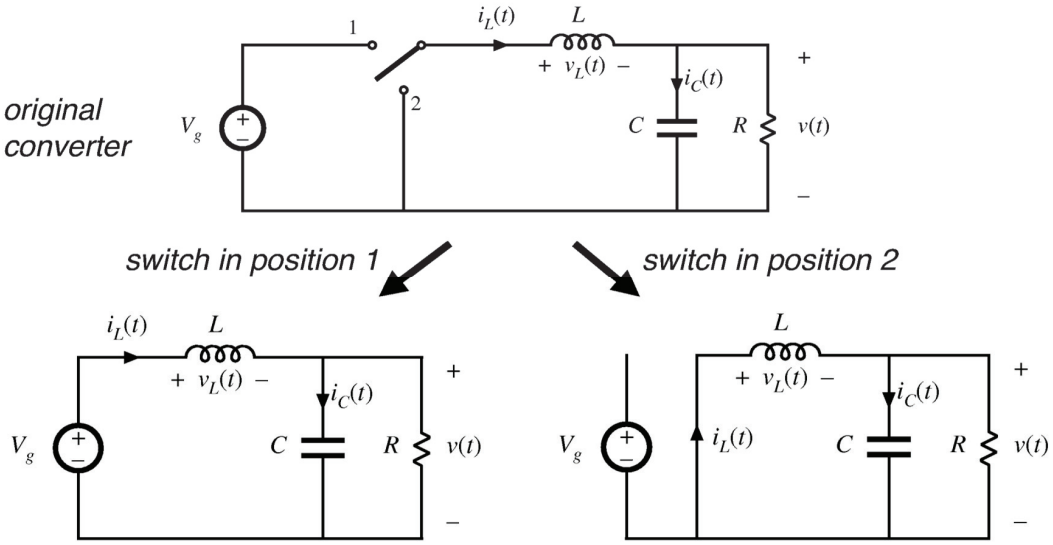
Model a switched system as an averaged, time-invariant system with

$$\dot{\boldsymbol{x}}(t) = \boldsymbol{A}\boldsymbol{x}(t) + \boldsymbol{B}u(t)$$

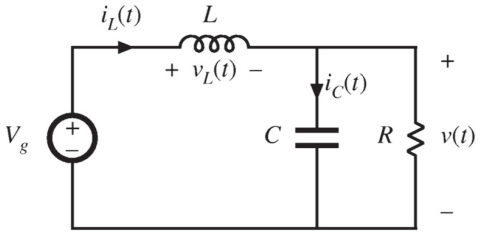
where

$$\boldsymbol{A} = D\boldsymbol{A_1} + D'\boldsymbol{A_2}$$
$$\boldsymbol{B} = D\boldsymbol{B_1} + D'\boldsymbol{B_2}$$

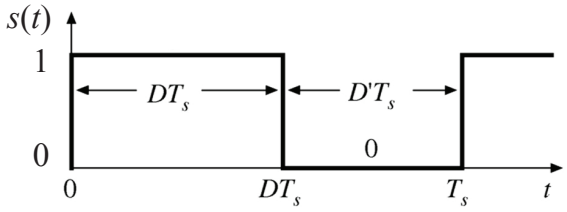
Large Signal Modeling of SMPS: Averaging



Linear Circuit Modeling Using State Space

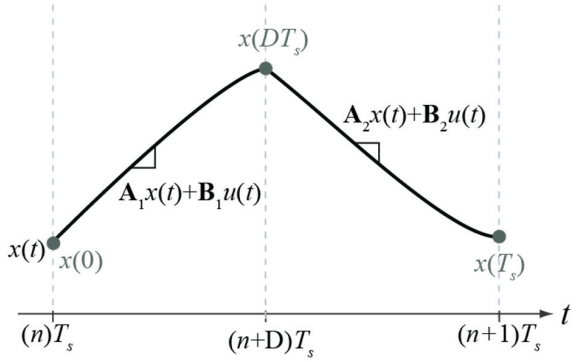


Switching Signal

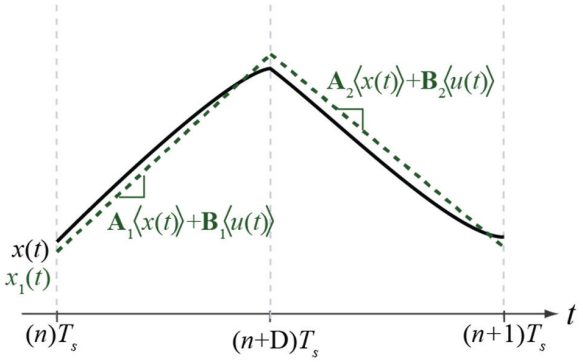


Converting to Linear System

Approximate Steady State Waveforms

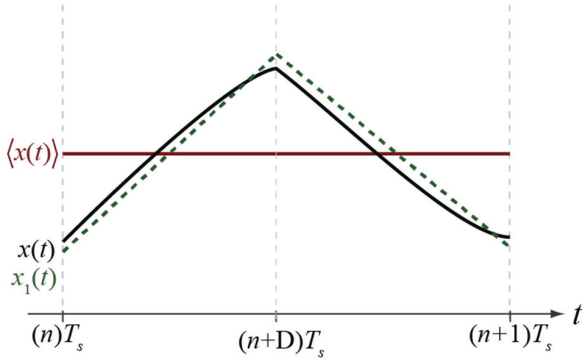


Approximate Steady State Waveforms



$$\langle x(t)\rangle = \frac{1}{T_s}\int_0^{T_s} x(t)dt$$

Approximate Steady State Waveforms



The Averaging Approximation

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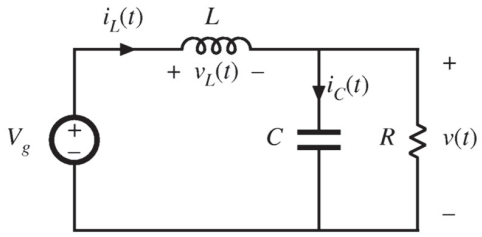
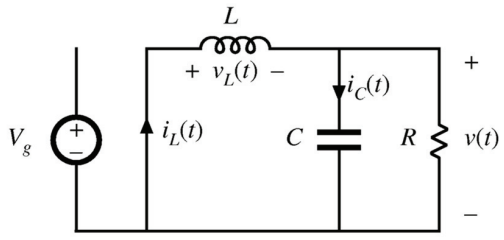
The Averaged System

Buck State Space Averaging





Buck Averaged Model