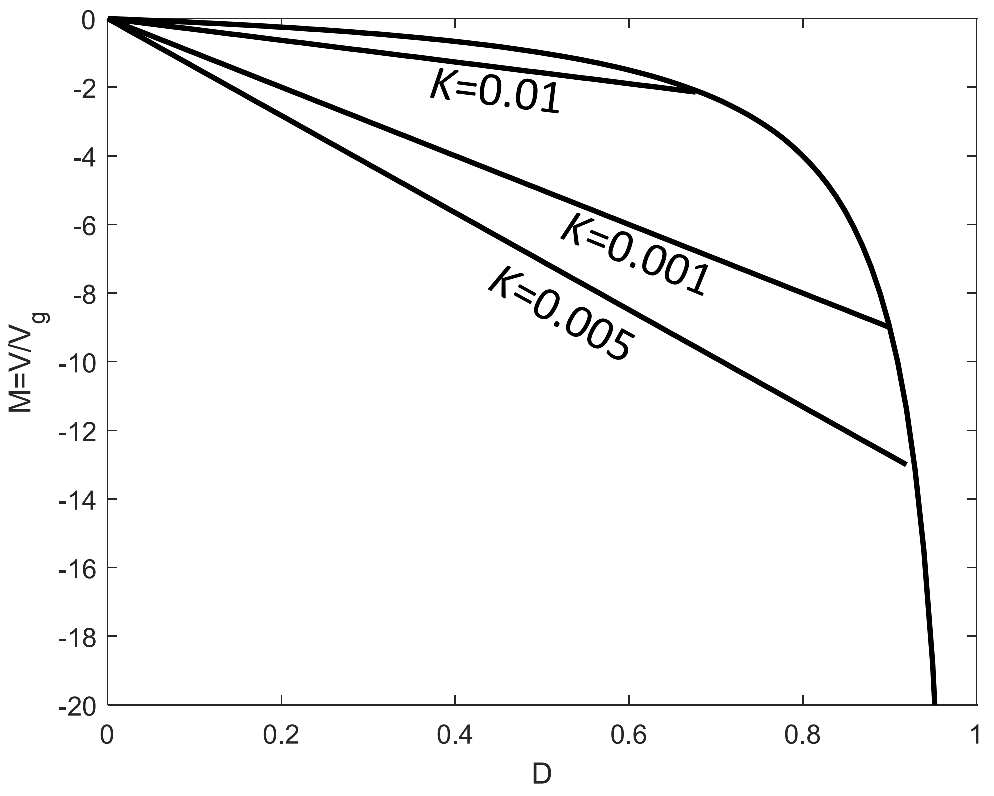
Cuk DCM M(D,K)



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Summary of DCM Characteristics

Table 5.2. Summary of CCM-DCM characteristics for the buck, boost, and buck-boost converters

Converter	$K_{crit}(D)$	DCM $M(D,K)$	DCM $D_2(D,K)$	CCM $M(D)$
Buck	$(1 - D)$	$\dfrac{2}{1+\sqrt{1+4K/D^2}}$	$\dfrac{K}{D}M(D,K)$	D
Boost	$D(1-D)^2$	$\dfrac{1+\sqrt{1+4D^2/K}}{2}$	$\dfrac{K}{D}M(D,K)$	$\dfrac{1}{1-D}$
Buck-boost	$(1-D)^2$	$-\dfrac{D}{\sqrt{K}}$	$\sqrt{K}$	$-\dfrac{D}{1-D}$

with $K = 2L/RT_s$. DCM occurs for $K < K_{crit}$.

Chapter 6

CONVERTER TOPOLOGIES

6.2 - A Short List of Converters

An infinite number of converters are possible, which contain switches embedded in a network of inductors and capacitors

Two simple classes of converters are listed here:

- Single-input single-output converters containing a single inductor. The switching period is divided into two subintervals. This class contains eight converters.
- Single-input single-output converters containing two inductors. The switching period is divided into two subintervals. Several of the more interesting members of this class are listed.

Single Input/Output/Inductor Converters

- Use switches to connect inductor between source and load, in one manner during first subinterval and in another during second subinterval
- There are a limited number of ways to do this, so all possible combinations can be found
- After elimination of degenerate and redundant cases, eight converters are found:

dc-dc converters

buck boost buck-boost noninverting buck-boost

dc-ac converters

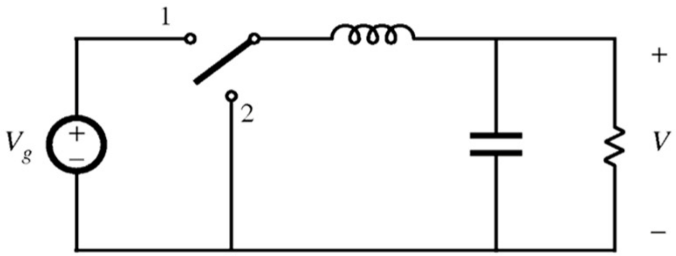
bridge Watkins-Johnson

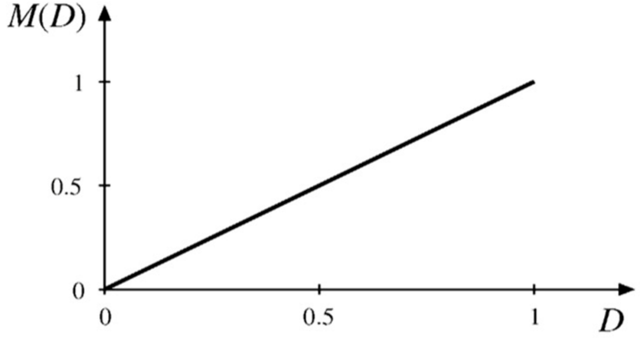
ac-dc converters

current-fed bridge inverse of Watkins-Johnson

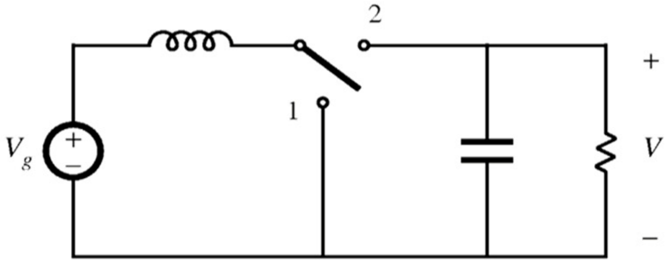
Unipolar Output Converters

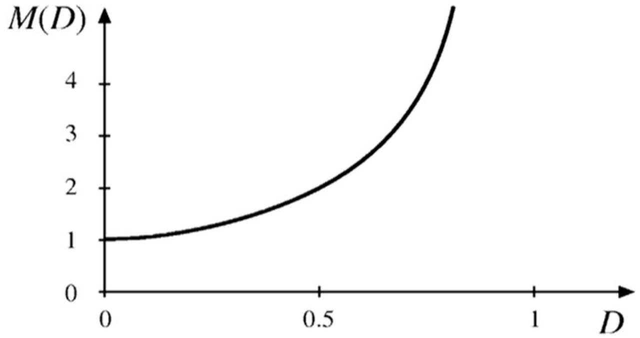
1. *Buck* $M(D) = D$





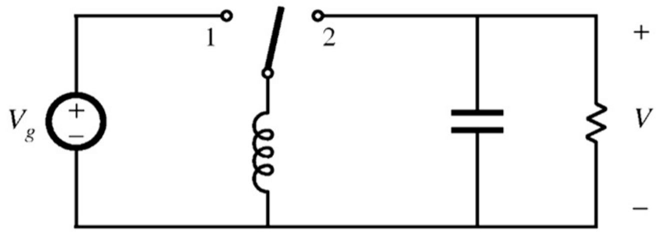
2. *Boost* $M(D) = \frac{1}{1-D}$

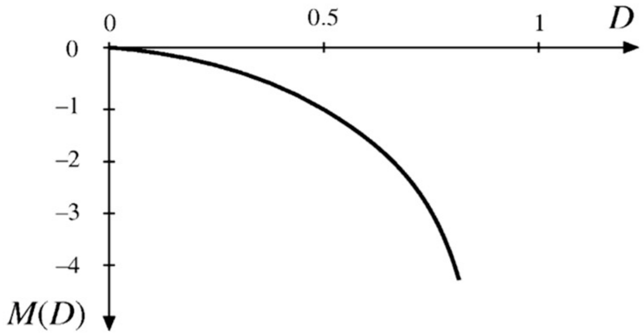




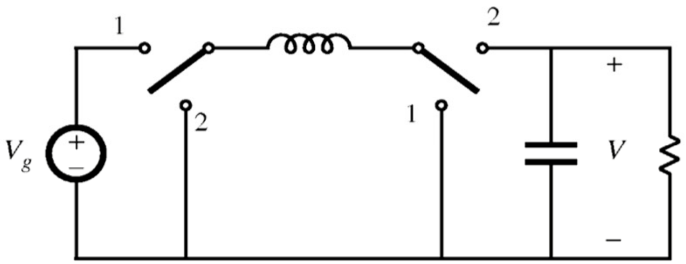
Unipolar Output Converters (cont.)

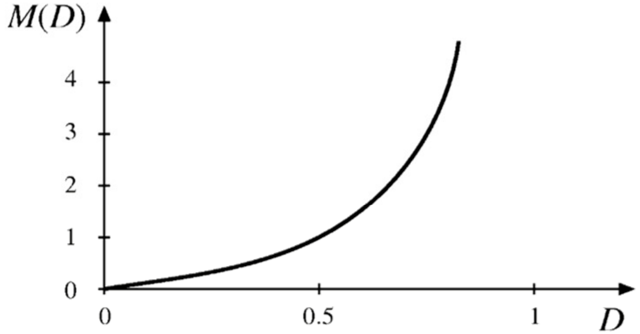
3. *Buck-boost* $M(D) = -\frac{D}{1-D}$





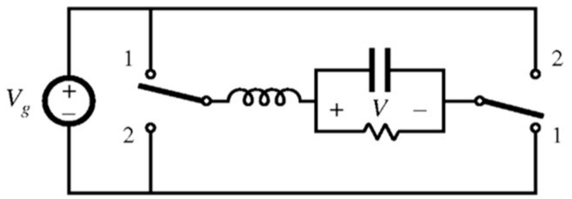
4. *Noninverting buck-boost* $M(D) = \frac{D}{1-D}$

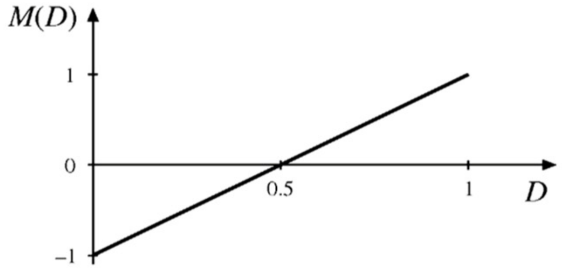




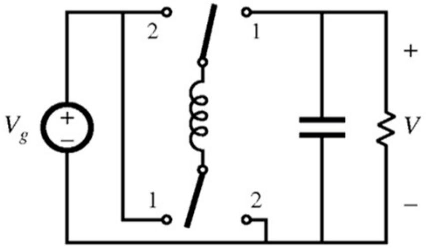
Bipolar Output Converters

5. *Bridge* $M(D) = 2D - 1$

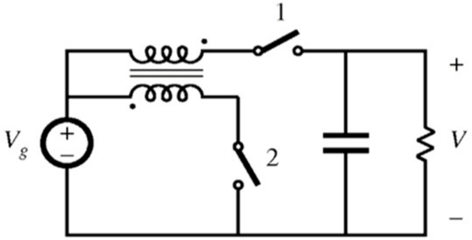


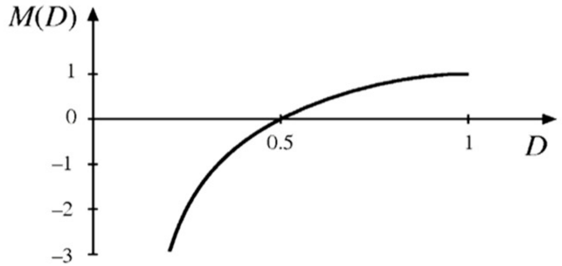


6. *Watkins-Johnson* $M(D) = \frac{2D - 1}{D}$



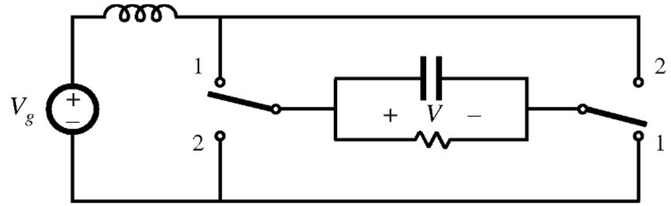
or

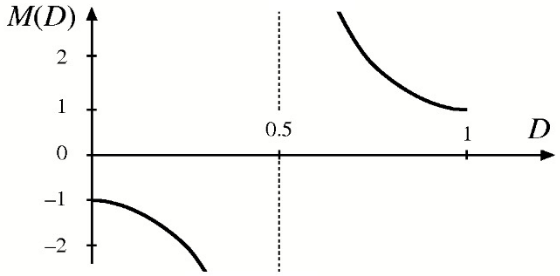




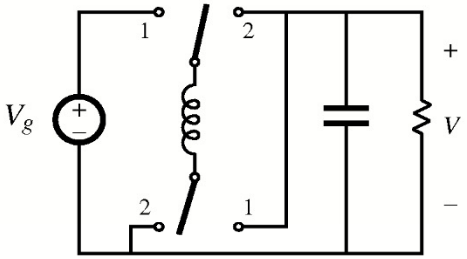
Bipolar Output Converters (cont.)

7. *Current-fed bridge* $M(D) = \dfrac{1}{2D - 1}$

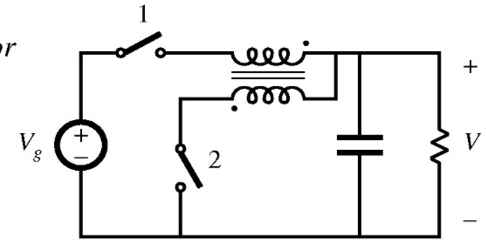


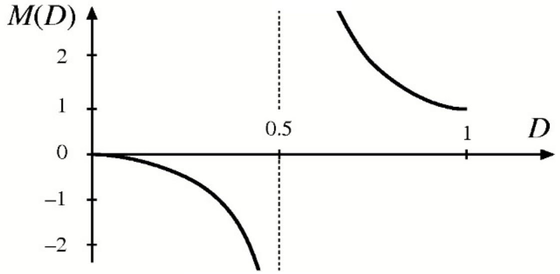


8. *Inverse of Watkins-Johnson* $M(D) = \dfrac{D}{2D - 1}$

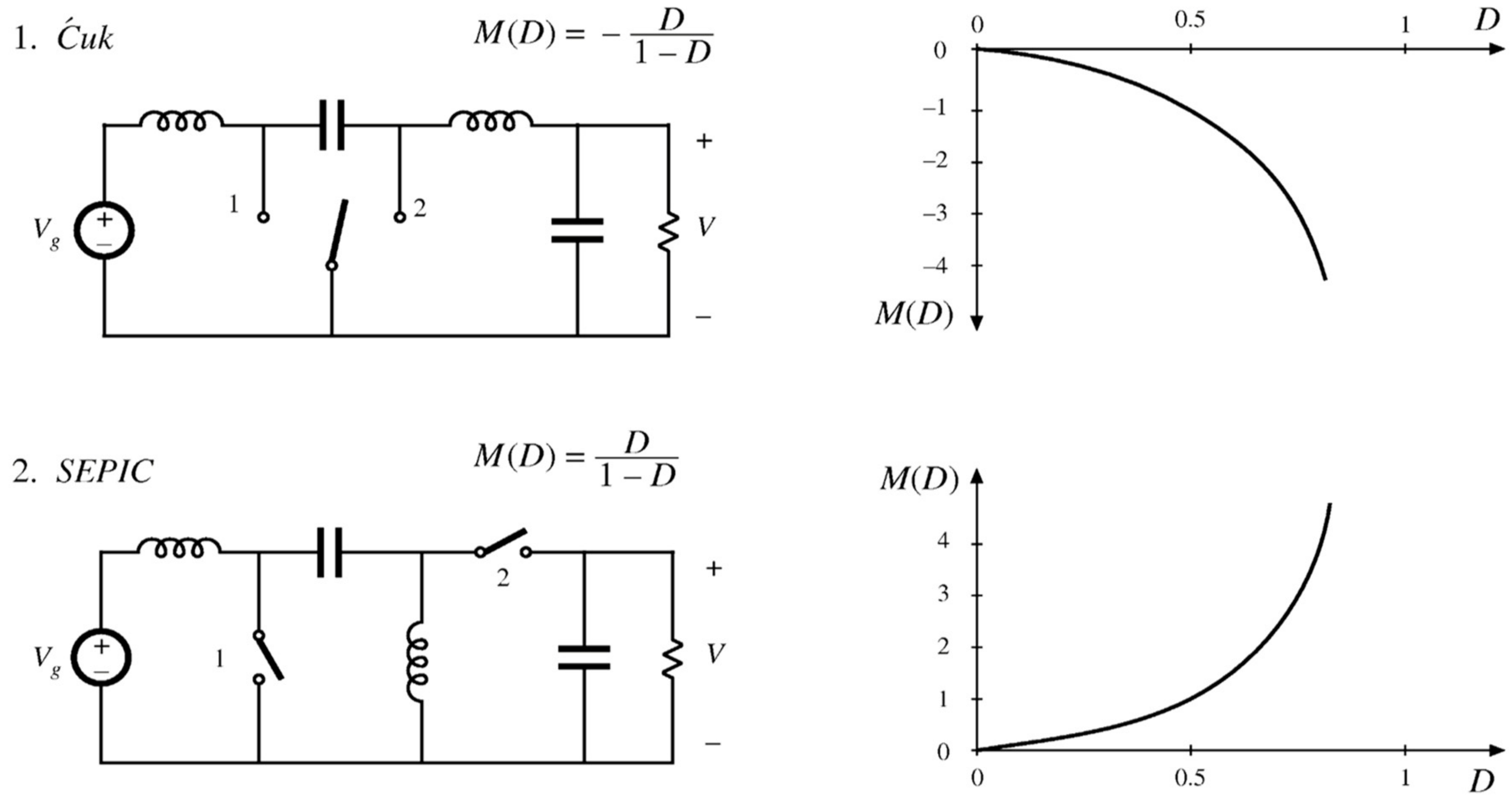


or



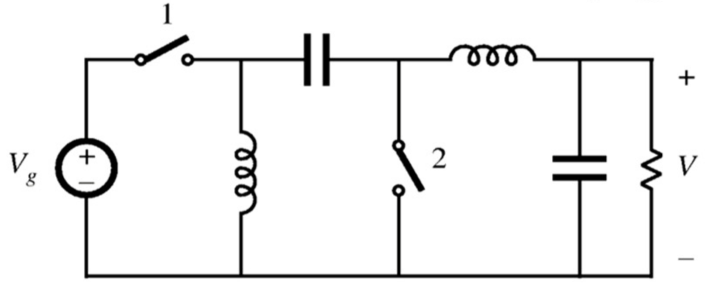


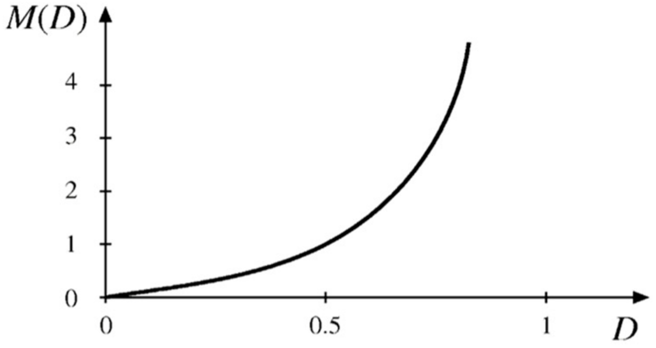
Example Two-Inductor Converters



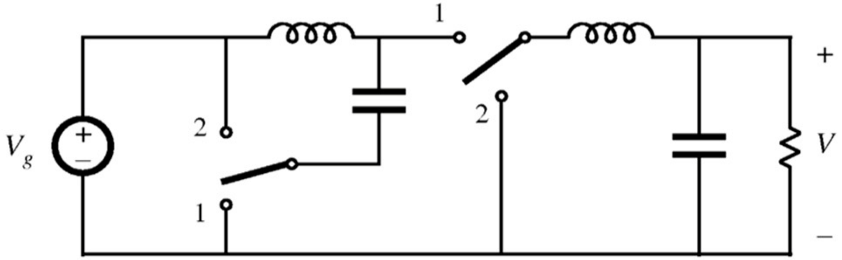
Example Two-Inductor Converters (cont.)

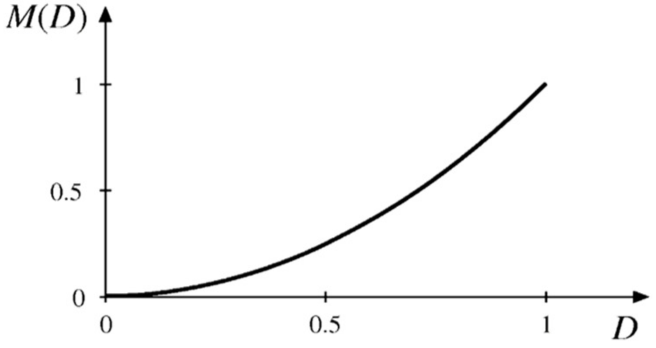
3. *Inverse of SEPIC* $M(D) = \dfrac{D}{1-D}$





4. *Buck*^{2} $M(D) = D^2$



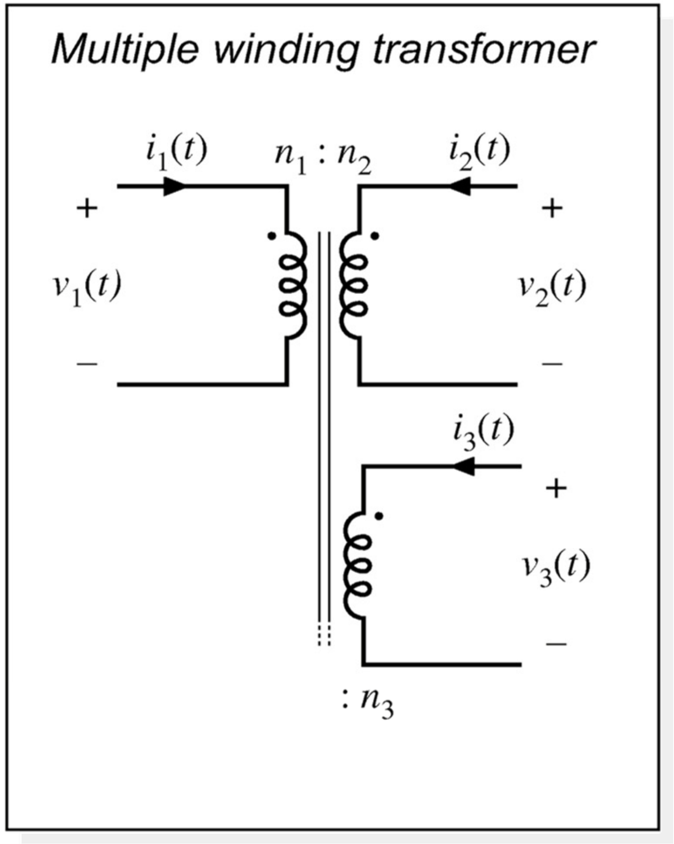


6.3 - Transformer Isolation

Objectives:

- Isolation of input and output ground connections, to meet safety requirements
- Reduction of transformer size by incorporating high frequency isolation transformer inside converter
- Minimization of current and voltage stresses when a large step-up or step-down conversion ratio is needed —use transformer turns ratio
- Obtain multiple output voltages via multiple transformer secondary windings and multiple converter secondary circuits

Ideal Transformer Model



$$\frac{v_1(t)}{n_1} = \frac{v_2(t)}{n_2} = \frac{v_3(t)}{n_3} = \ldots$$

$$0 = n_1 i_1'(t) + n_2 i_2(t) + n_3 i_3(t) + \ldots$$

Transformer Saturation