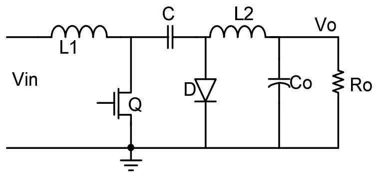
Advanced topologies
Half-bridge, Full-bridge, Push-Pull, C'uk, SEPIC

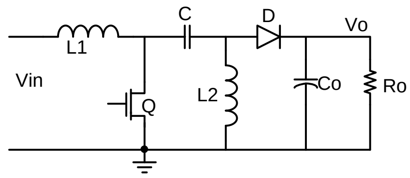
- C'uk
- Sepic
- Half-bridge
  - Symmetrical operation
    - Double power supply
    - Principle of operation , definition of D
    - Using bus capacitors – capacitive voltage division?
    - The concept of split bus capacitor
    - Component stress
  - Asymmetrical operation
- Full-bridge
  - Operation
  - Stress
- Reset
- Push-pull

Types of PWM converters
C'uk and SEPIC



C'uk

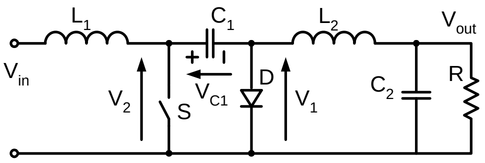
$$\frac{V_o}{V_{in}} = -\frac{D}{1-D}$$



SEPIC

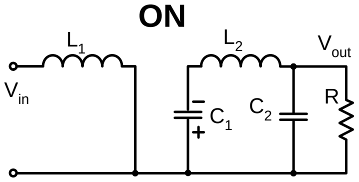
$$\frac{V_o}{V_{in}} = \frac{D}{1-D}$$

C’uk Converter

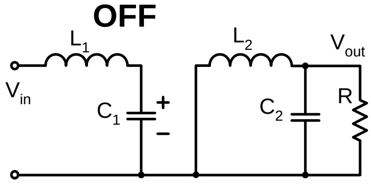


Voltage of $C_1 \approx$ constant

ON



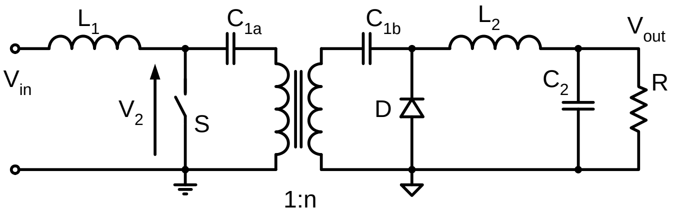
OFF



$$\overline{V_1} = V_o$$
$$\overline{V_2} = V_{in}$$
$$\overline{V_{c1}} = V_{in} - V_o$$

$$V_o = -V_{c1} \cdot D_{on} \quad \text{(buck)}$$
$$V_o = -(V_{in} - V_o) \cdot D_{on}$$
$$\frac{V_o}{V_{in}} = -\frac{D_{on}}{D_{off}}$$

C’uk with isolation

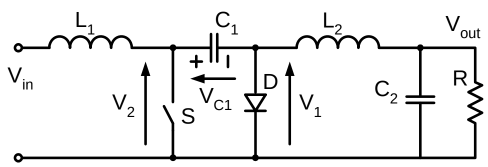


- Any polarity
- Any voltage ratio

$$\frac{V_o}{V_{in}} = \pm \frac{D_{on}}{D_{off}} n$$

C'uk Converter

Inductors on the same core



Can be done only if the voltage on the windings are equal

C'uk advnatages and disadvantages

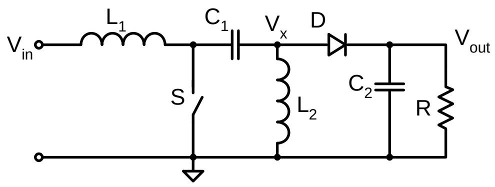
Advantages

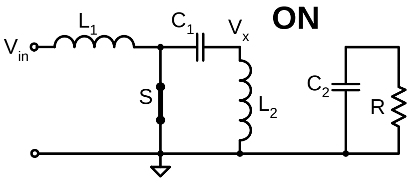
- Continues input **and** output currents
- Single switch
- Step-up and step-down

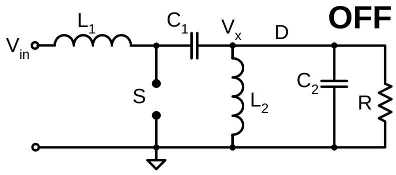
Disadvantages

- Two inductors
- Extra capacitor (of high rms current)
- Difficult to stabilize
- High voltage on switch $|V_{in}| + |V_{out}|$

SEPIC Converter







$$\overline{V}_{L1} = 0$$

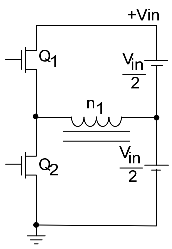
$$\overline{V}_{L2} = 0$$

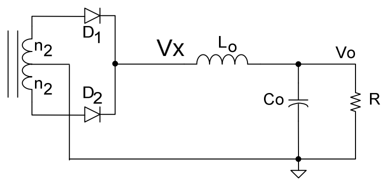
$$\overline{V}_{C1} = V_{in}$$

$$\overline{V}_x = V_o \cdot D_{off} - V_{in} \cdot D_{on} = 0$$

$$\frac{V_o}{V_{in}} = \frac{D_{on}}{D_{off}}$$

Half-bridge

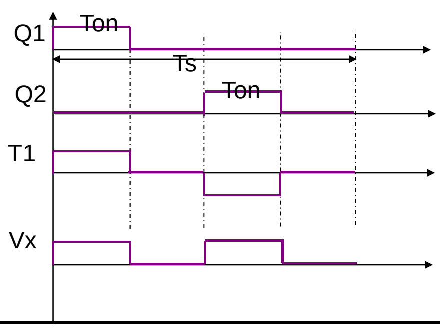




HB,
symmetrical operation

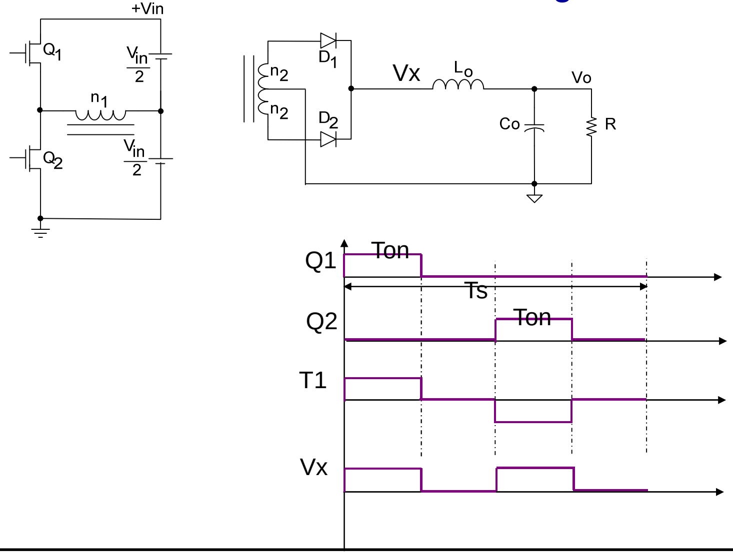
$$\frac{V_o}{V_{in}} = \frac{n1}{n2} D$$

$$D = \frac{t_{on}}{T_s/2}$$



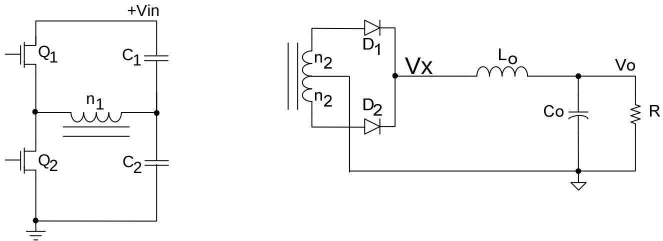
Half-bridge

What is the transformer voltage at off time



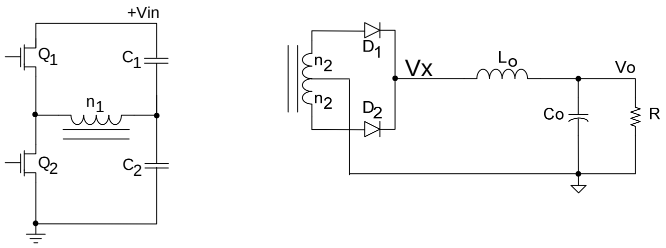
Types of PWM converters

HB –Capacitors to replace supplies



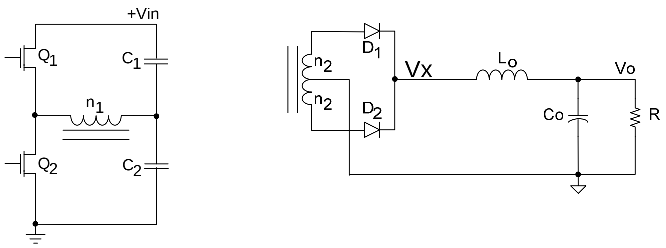
Types of PWM converters

HB -Concept of split bus capacitors



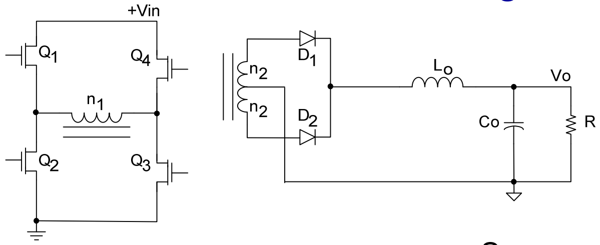
Types of PWM converters

Asymmetrical operation – synchronous rectifier

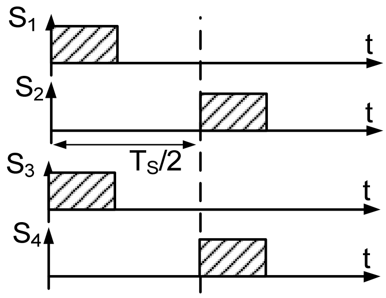


Motivation to asymmetrical operation: Spikes and oscillations at the mid point an off time

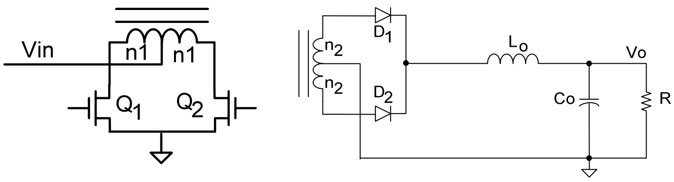
Full-bridge



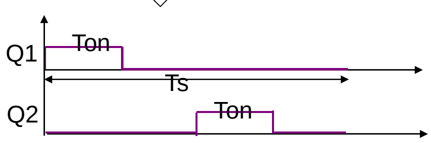
$$\frac{V_o}{V_{in}} = 2\frac{n1}{n2}D$$



Push-pull

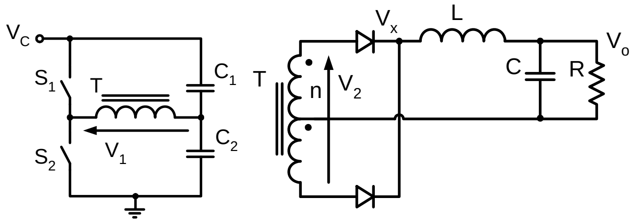


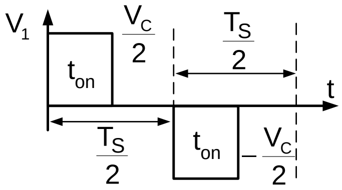
$$\frac{V_o}{V_{in}} = 2\frac{n1}{n2}D$$



Reset of Forward, HB, FB

- Forward - auxiliary winding
- HB,FB - Natural





Forward, HB, FB, PP

I_L ripple for same L

- Forward: ΔI
- HB, FB, PP: $\frac{\Delta I}{2}$

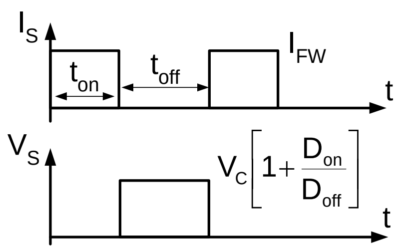
Switch Utilization

Important consideration: V_s(off), I_s(on)

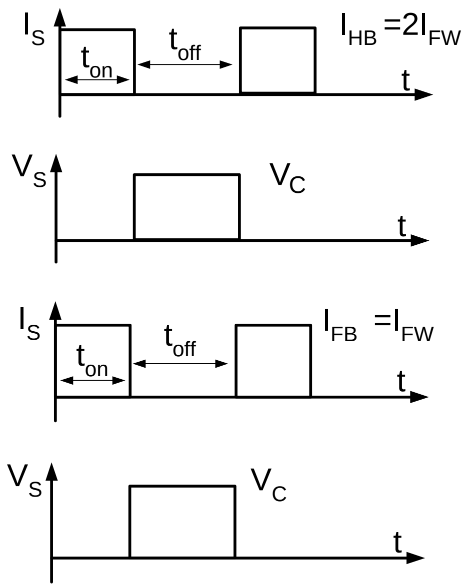
Assumption:

- Same input and output power
- Same input voltage

FORWARD



Waveforms

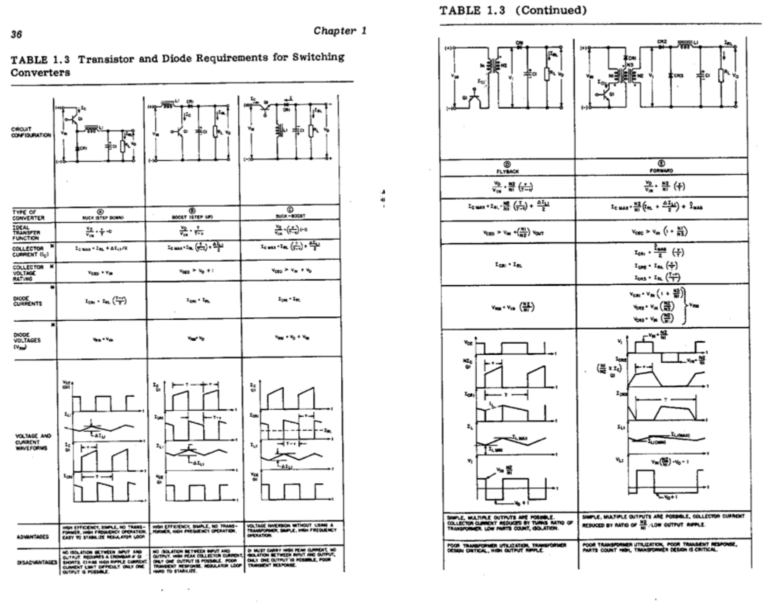


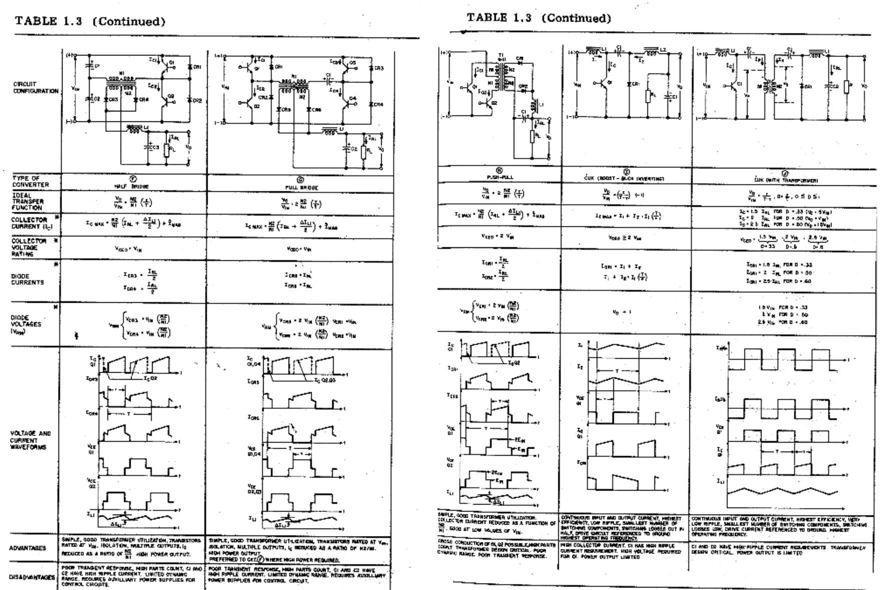
HB

FB

Types of PWM converters Comparison chart

Converter	Sw current	Sw voltage
Buck	Io	Vin
Boost	Io(Don/Doff)	Vo
Buck-Boost	Io(Don/Doff)	Vin+Vo
C'uk	Iin+Io	Vin+Vo
SEPIC	Iin+Io	Vin+Vo
Forward	Io*(n2/n1)	Vin+Vrst
Flyback	Io*(n2/n1)(Don/Doff)	Vin+Vo*(n1/n2)
HB	2Io *(n2/n1)	Vin
FB	Io *(n2/n1)	Vin/2
PP	Io *(n2/n1)	2Vin





*For reliable operation, it is suggested and recommended that all voltage and current ratings be increased to 125% of the required maximum.