

### Half Bridge, Full Bridge, Push-Pull, Cuk, SEPIC

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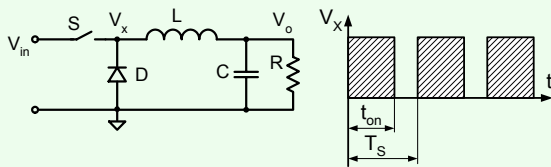
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### Buck topology



Buck derived topologies

- Forward - one switch
- Half Bridge HB - two switches
- Full Bridge FB - four switches

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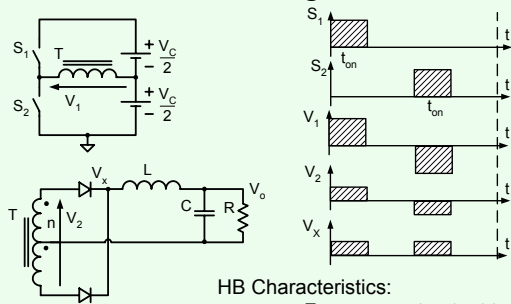
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### Half Bridge HB



HB Characteristics:

- Frequency at output twice  $f_s$
- Output section: Buck

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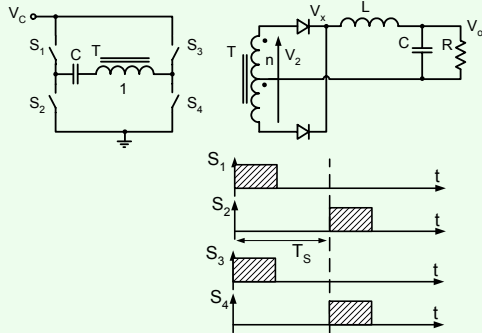
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### Full Bridge FB




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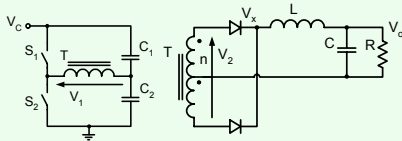
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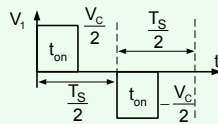
### Reset of Forward, HB, FB

- Forward - auxiliary winding
- HB,FB - Natural

Example HB



- $C_1, C_2$  capacitor divider




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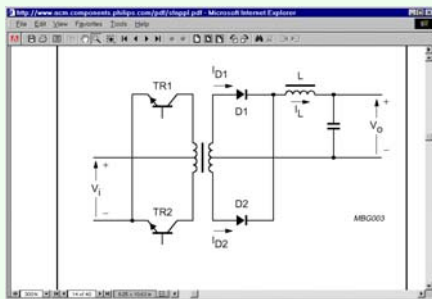
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### Push-Pull




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### Forward, HB, FB, PP

$I_L$  ripple for same L

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

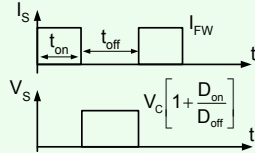
Switch Utilization

Important consideration:  $V_s(\text{off}), I_s(\text{on})$

Assumption:

- Same input and output power
- Same input voltage

#### **FORWARD**




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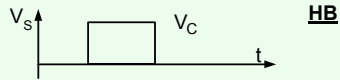
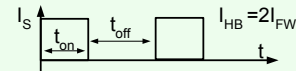
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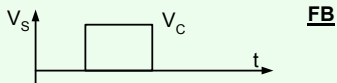
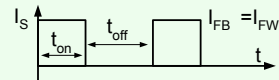
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### Waveforms



**HB**



**FB**

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### Stresses

|    | $I_s$ | V                            |
|----|-------|------------------------------|
| FW | 1     | $1 + \frac{D_{on}}{D_{off}}$ |
| HB | 2     | 1                            |
| PP | 1     | 2                            |
| FB | 1     | 1                            |

- Power conversion capability:  $FW < HB < FB$

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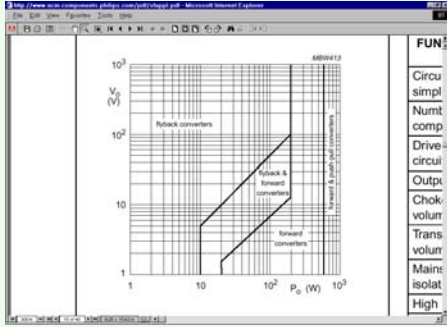
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### Topology selection




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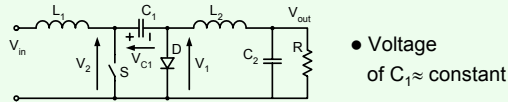
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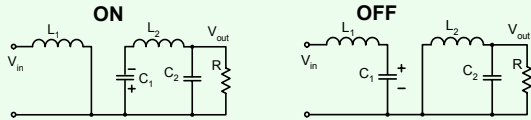
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### Cuk Converter



• Voltage of  $C_1 \approx$  constant



$$\begin{aligned} \bar{V}_1 &= V_o & V_o &= -V_{c1} \cdot D_{on} \text{ (buck)} \\ \bar{V}_2 &= V_{in} & V_o &= -(V_{in} - V_o) \cdot D_{on} \\ \bar{V}_{c1} &= V_{in} - V_o & \frac{V_o}{V_{in}} &= -\frac{D_{on}}{D_{off}} \end{aligned}$$

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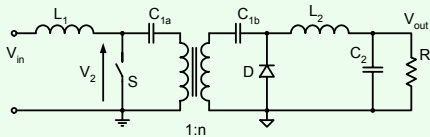
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### Cuk with isolation



- Any polarity
- Any voltage ratio

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

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### Cuk advnatages and disadvantages

#### Advantages

- Continuous 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  $|V_{in}| + |V_{out}|$

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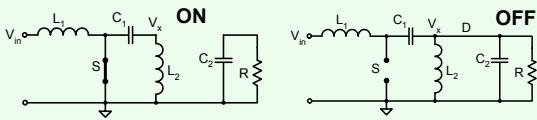
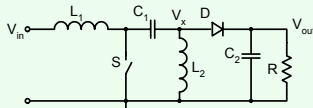
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### SEPIC Converter



$$\begin{aligned} \bar{V}_{L1} &= 0 & \bar{V}_x &= V_o \cdot D_{off} - V_{in} \cdot D_{on} = 0 \\ \bar{V}_{L2} &= 0 & \frac{V_o}{V_{in}} &= \frac{D_{on}}{D_{off}} \\ \bar{V}_{C1} &= V_{in} \end{aligned}$$

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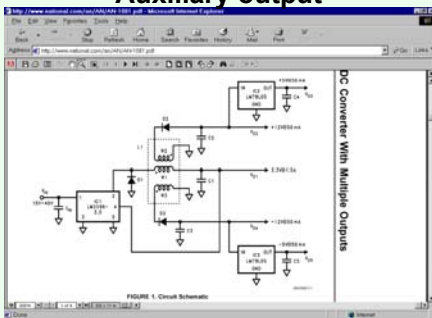
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### Auxiliary output




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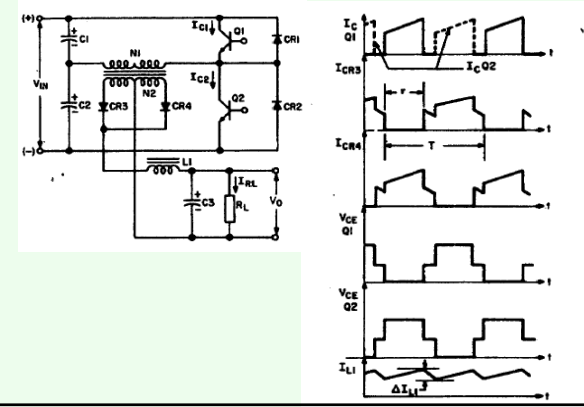
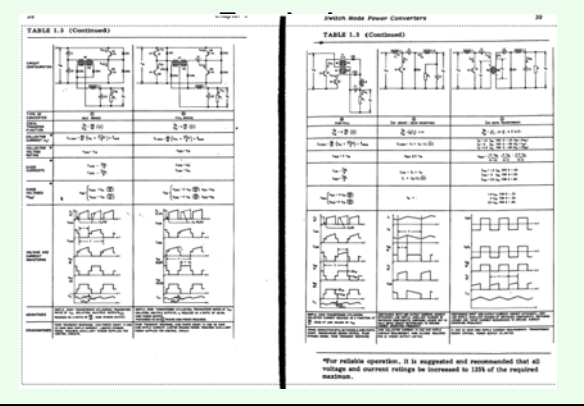
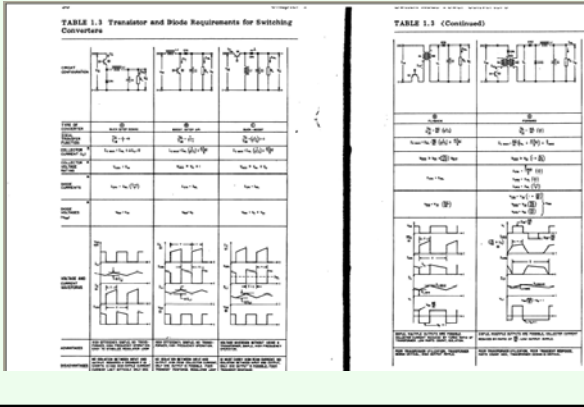
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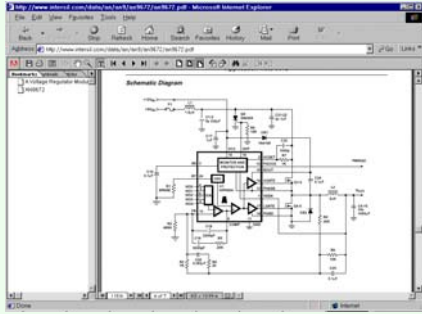
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## VOLTAGE REGULATION MODULE (VRM)

- Synchronous rectifier



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