

Mor M. Peretz, Switch-Mode Power Supplies [4-1]

### Isolated Converters Forward and Flyback

- DC current via transformer
- Forward
  - Voltage transfer function
  - Magnetizing inductance
  - Transformer reset
- Coupled inductors
- Flyback
  - Voltage transfer function
  - Multiple outputs

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Mor M. Peretz, Switch-Mode Power Supplies [4-2]

### DC current via transformer

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Mor M. Peretz, Switch-Mode Power Supplies [4-3]

### Forward converter (buck derived)

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Mor M. Peretz, Switch-Mode Power Supplies [4-4]

### Voltage transfer function – CCM

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Mor M. Peretz, Switch-Mode Power Supplies [4-5]

### Magnetizing inductance

- Current at Lm is interrupted (!)

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Mor M. Peretz, Switch-Mode Power Supplies [4-6]

### Transformer reset

Must make sure that the reset ends before the next cycle

$$V_{in} D_{on} = (V_{reset} - V_{in}) D_{off}$$


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Mor M. Peretz, Switch-Mode Power Supplies [4-7]

### Reset winding Auxiliary source

Requirement for reset:

$$D_{off} \frac{V_{reset}}{n_3} \geq \frac{V_{in}}{n_1} D_{on}$$


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Mor M. Peretz, Switch-Mode Power Supplies [4-8]

### Reset winding Same source

Requirement for reset:

$$D_{off} \frac{V_{in}}{n_3} \geq \frac{V_{in}}{n_1} D_{on}$$

$$\frac{n_1}{n_3} \geq \frac{D_{on}}{D_{off}}$$

Must make sure that the reset ends before the next cycle  
For calculations use Don-max

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Mor M. Peretz, Switch-Mode Power Supplies [4-9]

### Forward converter Schematic with reset

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Mor M. Peretz, Switch-Mode Power Supplies [4-10]

### Reset winding Calculation of $n_3$

For each winding:  $\bar{V} = 0$   
Calculation can be done from any winding

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Mor M. Peretz, Switch-Mode Power Supplies [4-11]

### Implication on the switch voltage stress

$$V_s = V_n + \frac{n_1}{n_3} V_n \quad \frac{n_1}{n_3} \geq \frac{D_{on}}{D_{off}}$$

$$V_s = V_n \left[ 1 + \frac{D_{on, max}}{1 - D_{on, max}} \right]$$


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Mor M. Peretz, Switch-Mode Power Supplies [4-12]

### Implication on the input current

Reset current

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Mor M. Peretz, Switch-Mode Power Supplies [4-13]

### Coupled inductors



$$\frac{L_1}{L_2} = \left(\frac{n_1}{n_2}\right)^2$$


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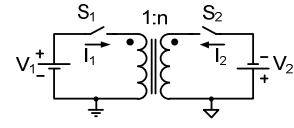
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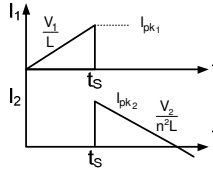
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Mor M. Peretz, Switch-Mode Power Supplies [4-14]

### Coupled inductors Current interruption



Energy stored in the core




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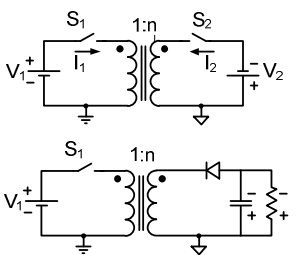
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Mor M. Peretz, Switch-Mode Power Supplies [4-15]

### Replacing switch by a diode




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Mor M. Peretz, Switch-Mode Power Supplies [4-16]

**Flyback converter  
buck-boost derived**

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

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

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Mor M. Peretz, Switch-Mode Power Supplies [4-17]

**Voltage transfer function – CCM  
average voltage method**

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Mor M. Peretz, Switch-Mode Power Supplies [4-18]

**Voltage transfer function – CCM  
 $\Delta I$  method**

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Mor M. Peretz, Switch-Mode Power Supplies [4-19]

### Multiple outputs Effect of coupling

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Mor M. Peretz, Switch-Mode Power Supplies [4-20]

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Mor M. Peretz, Switch-Mode Power Supplies [4-21]

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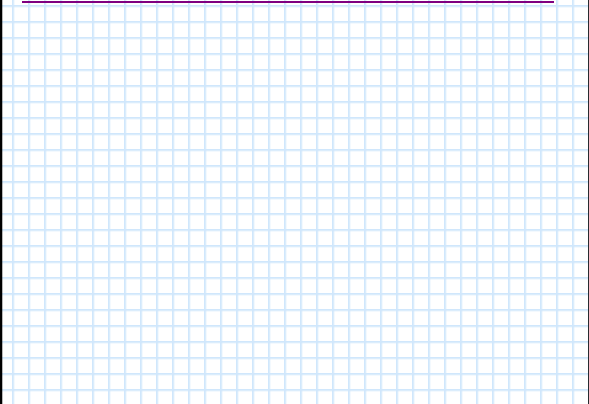
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 Mor M. Peretz, Switch-Mode Power Supplies [4-22]

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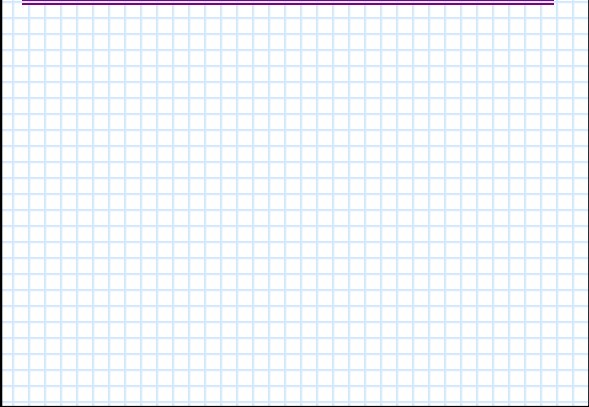
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 Mor M. Peretz, Switch-Mode Power Supplies [4-23]

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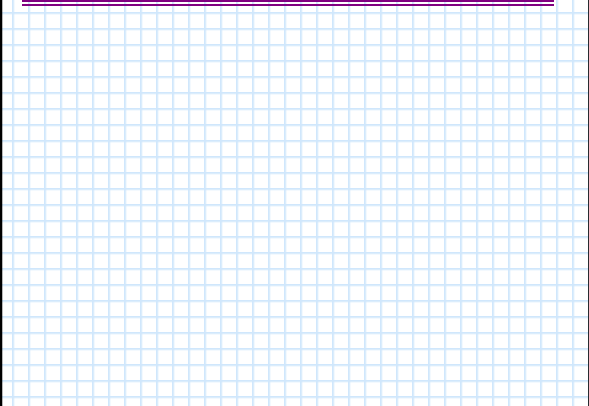
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 Mor M. Peretz, Switch-Mode Power Supplies [4-24]

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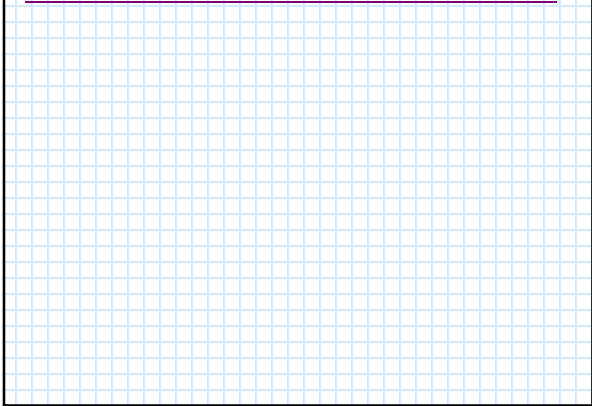
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