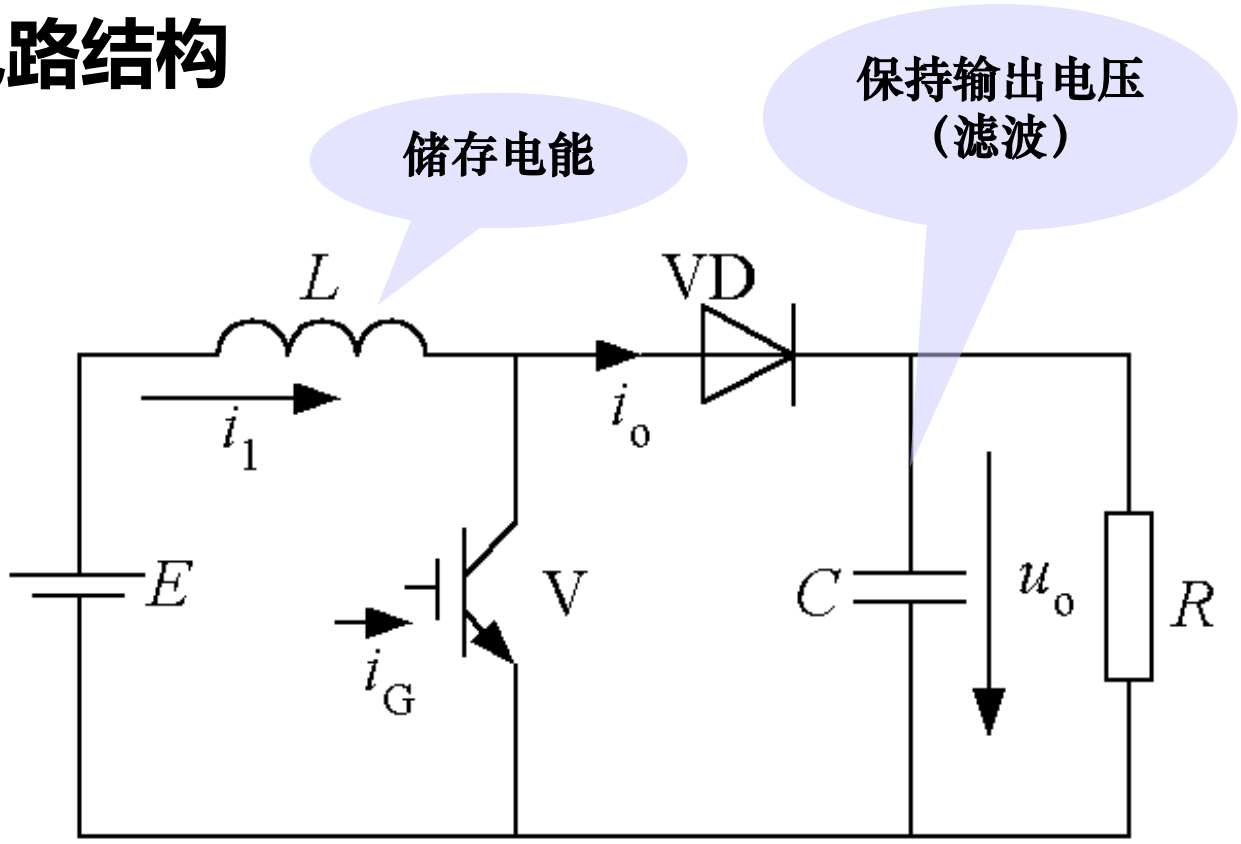
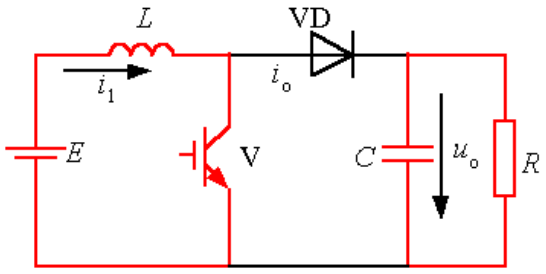
2.2 升压斩波电路(Boost)

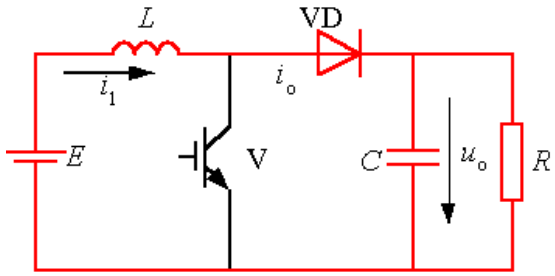
- 电路结构



本质：利用电感L中的储能释放时产生的电压来提高输出电压



工作方式1



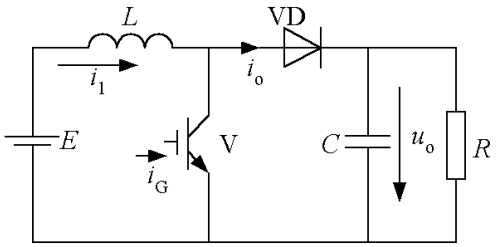
工作方式2

工作方式1

■ V通态：电源E向电感L充电，电容C向负载R供电。

工作方式2

■ V断态：电源E和电感L同时向电容C充电，并向负载提供能量。



(1) 电流连续

■ **电感伏秒平衡原理：**

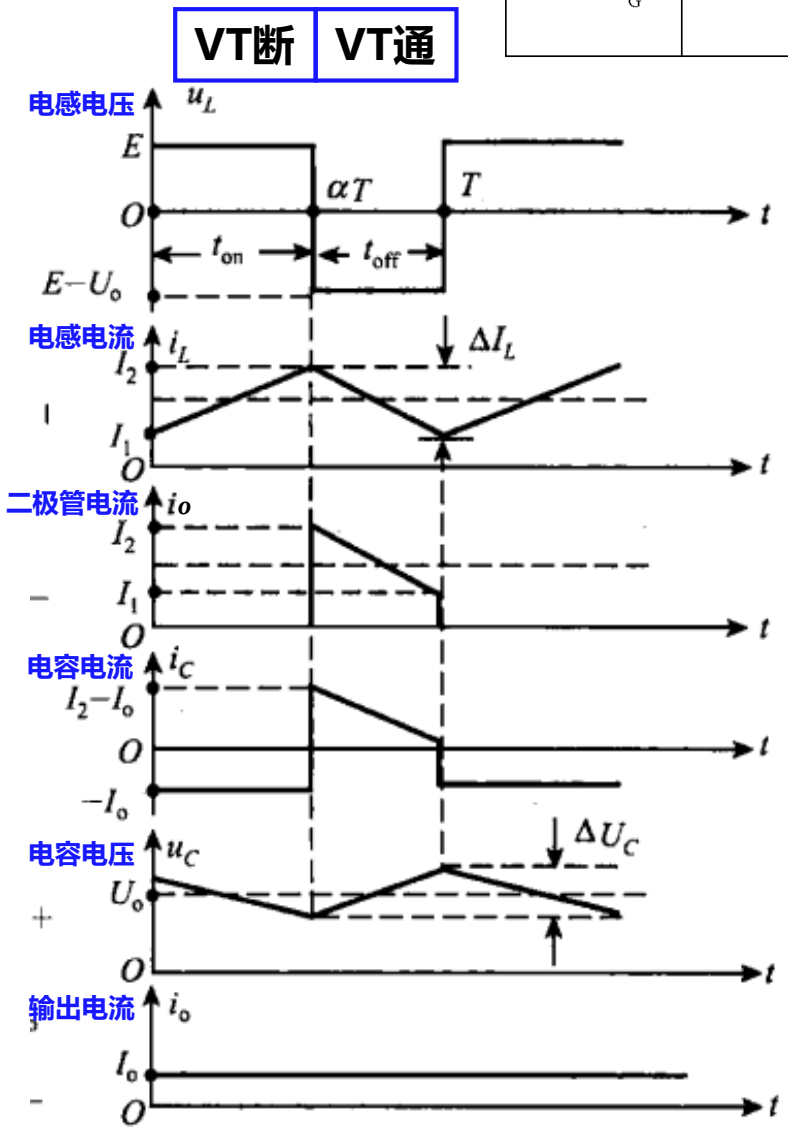
$$(E-U_0)t_{off}+Et_{on}=0$$

输入输出关系 ⇨ $\dfrac{U_0}{E}=\dfrac{t_{on}+t_{off}}{t_{off}}=\dfrac{1}{1-\alpha}$

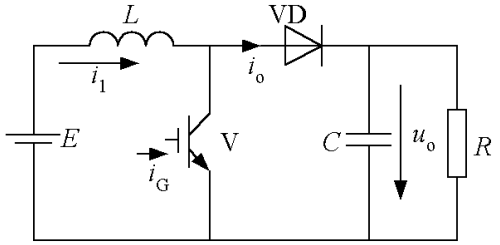
■ **功率平衡原理：**

$$EI=U_0I_0$$

输入输出关系 ⇨ $\dfrac{I_0}{I}=\dfrac{I_0}{I_L}=\dfrac{E}{U_0}=1-\alpha$



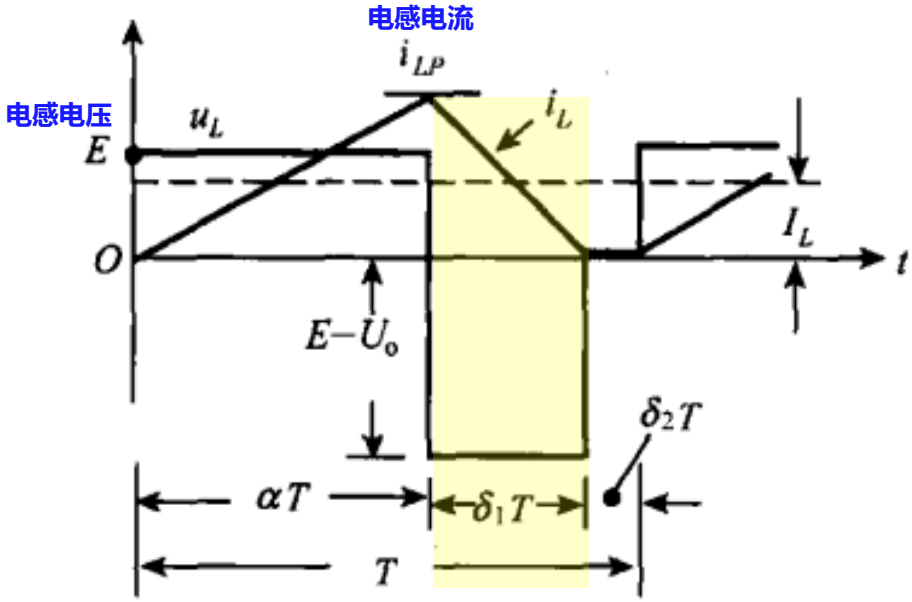
(2) 电流断续



电感伏秒平衡原理：

$$E\alpha T+(E-U_o)\delta_1 T=0$$

⇨ **输入输出关系** $\dfrac{U_0}{E}=\dfrac{\alpha+\delta_1}{\delta_1}$



功率平衡原理：

$$EI=U_0 I_0$$

⇨ **输入输出关系** $\dfrac{I_0}{I_L}=\dfrac{\delta_1}{\alpha+\delta_1}$

电感电流峰值： $i_{Lp}=\dfrac{E}{L}\alpha T$

输入电流与电感电流平均值： $I=I_L=i_{Lp}\dfrac{\alpha+\delta_1}{2}=\dfrac{ET}{2L}\alpha(\alpha+\delta_1)$

⇨ $I_o=\dfrac{\delta_1}{\alpha+\delta_1}I_L=\dfrac{ET}{2L}\alpha\delta_1$

■ L、C滤波器设计：

目的： 减小U_0脉动

- **电感电流纹波**

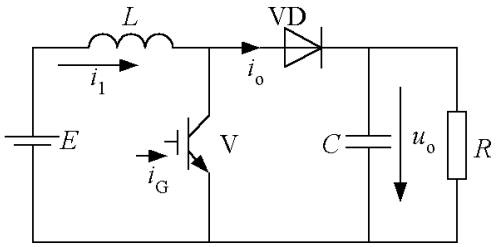
$$\begin{cases} Et_{on} = \Delta I_L L & \text{电流上升} \\ -(E-U_o)t_{off} = \Delta I_L L & \text{电流下降} \end{cases}$$

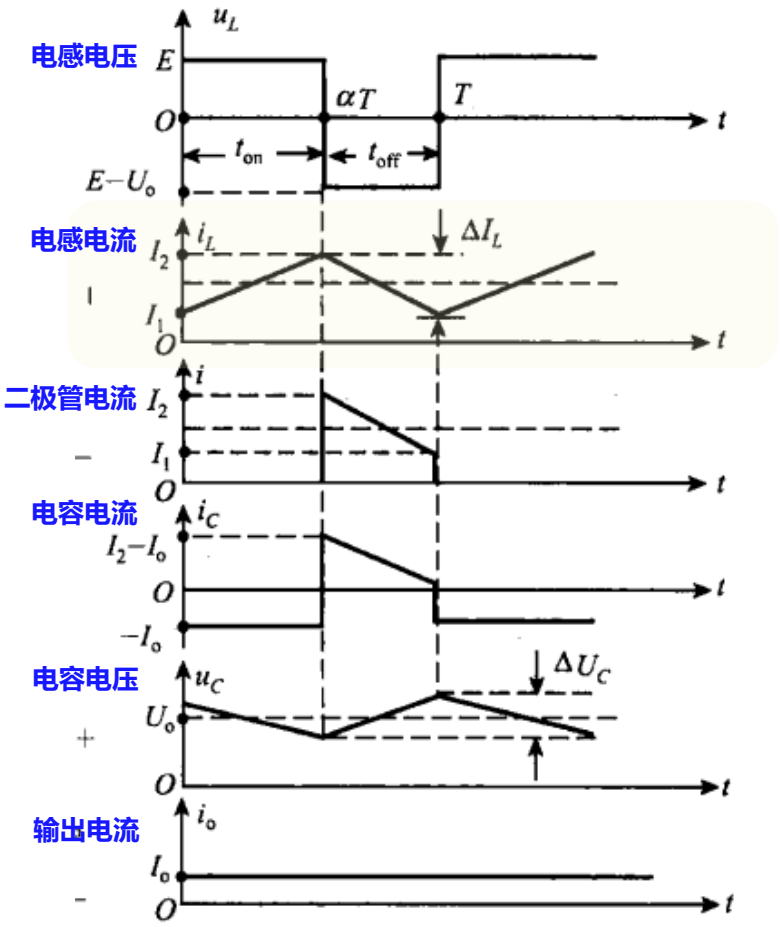
$$\Rightarrow \begin{cases} t_{on} = \dfrac{\Delta I_L L}{E} \\ t_{off} = \dfrac{\Delta I_L L}{U_o - E} \end{cases}$$

$$\Rightarrow T = t_{on} + t_{off} = \frac{\Delta I_L L U_o}{E(U_o - E)}$$

电感电流纹波 $$\Rightarrow \Delta I_L = \frac{E(U_o - E)}{fLU_o} = -\frac{\alpha E}{fL}$$

其中：$\alpha = \dfrac{t_{on}}{T} = \dfrac{U_o - E}{U_o}$

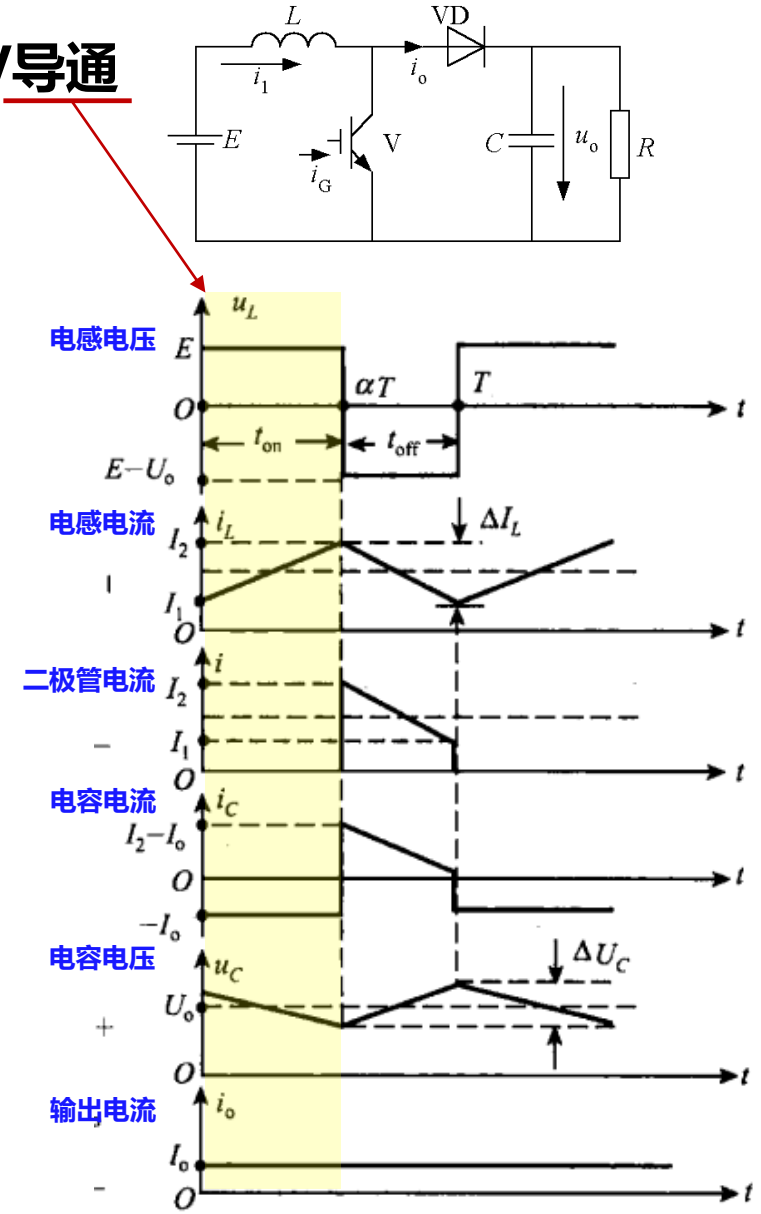




- **电容电压纹波：忽略负载电流纹波，V导通时：$i_c = I_0$，则**

$$\begin{cases} \Delta U_C = \dfrac{1}{C}\int_0^{t_{on}} i_C dt = \dfrac{I_o t_{on}}{C} \\ t_{on} = \alpha T = \dfrac{U_o - E}{U_o f} \\ \alpha = \dfrac{U_o - E}{U_o} \end{cases}$$

⇨ **电容电压纹波** $\Delta U_C = \dfrac{I_o(U_o - E)}{fCU_o} = \dfrac{I_o \alpha}{fC}$



结论：

- ✓ f越大，纹波越小
- ✓ C越大，纹波越小
- ✓ α越大，纹波越大