Osnove elektronike
III semestar

LINEARNI IZVORI ZA NAPAJANJE

Sastavni delovi

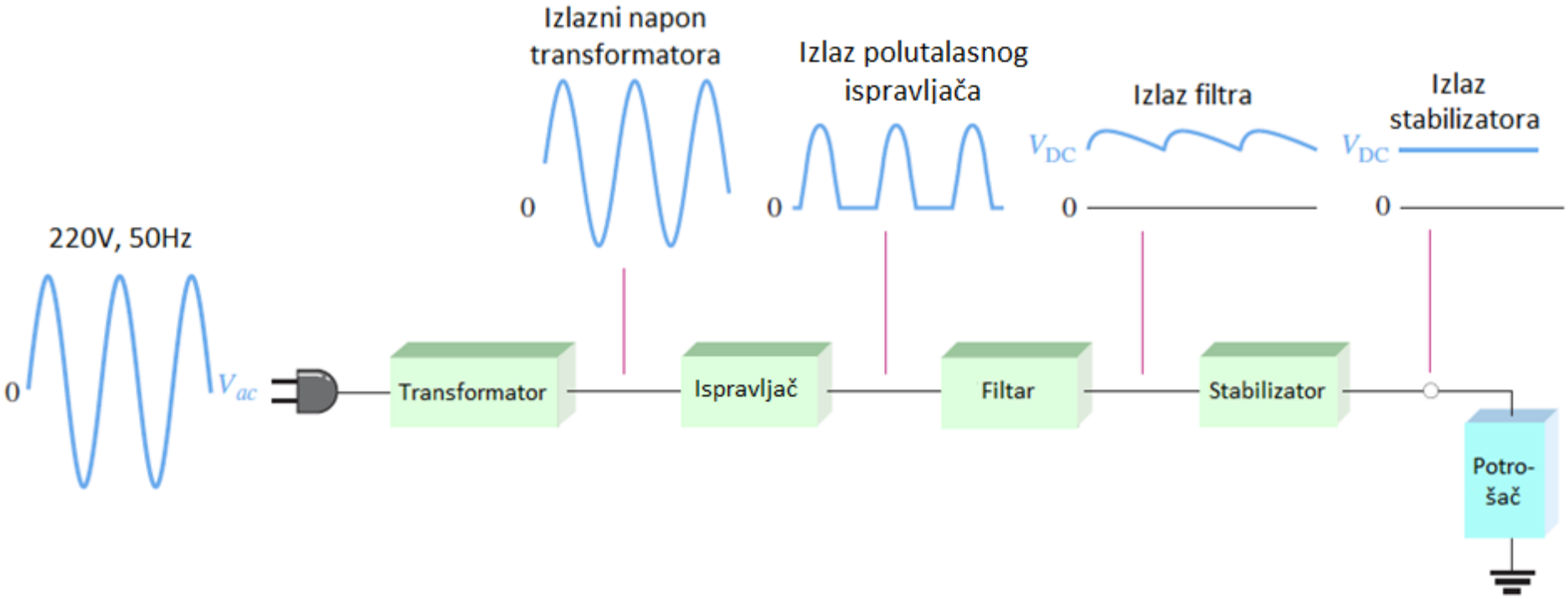
Linearni izvori za napajanje tipično omogućavaju generisanje jednosmernog napona za napajanje elektronskih kola od mrežnog naizmeničnog napona.

Sastavni delovi linearnih izvora za napajanje su:

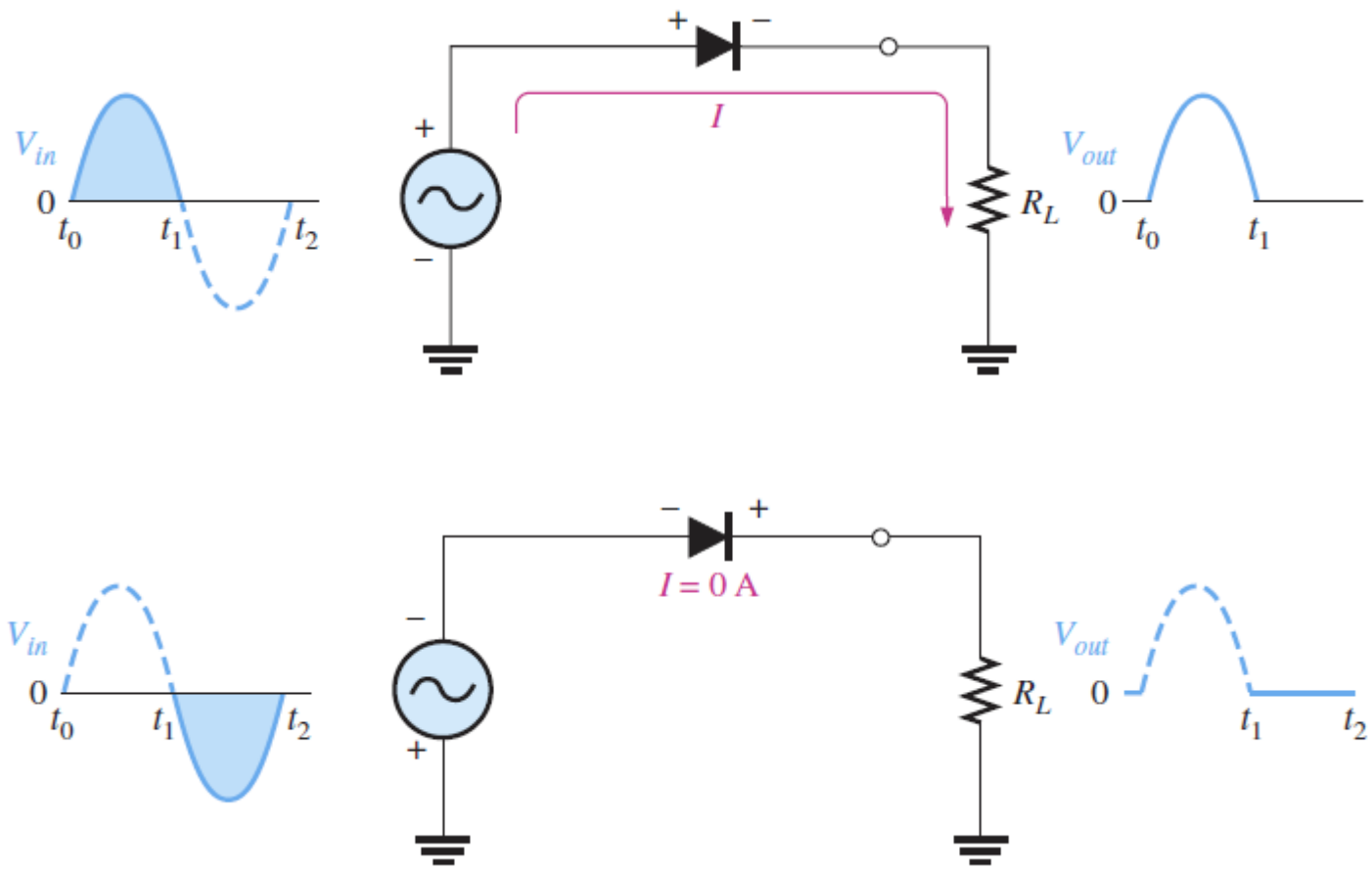
- transformator
- ispravljač
- filter
- stabilizator napona.

Linearni izvori za napajanje koji omogućavaju generisanje nižeg jednosmernog napona za napajanje elektronskih kola od višeg jednosmernog napona baterije se sastoje samo od stabilizatora napona.

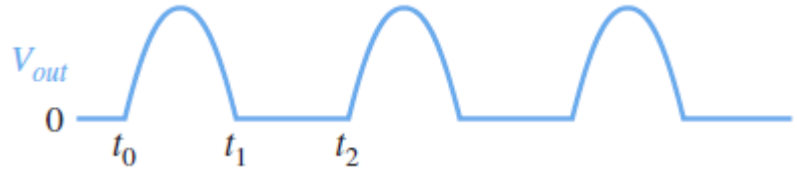
Linearni izvori za napajanje

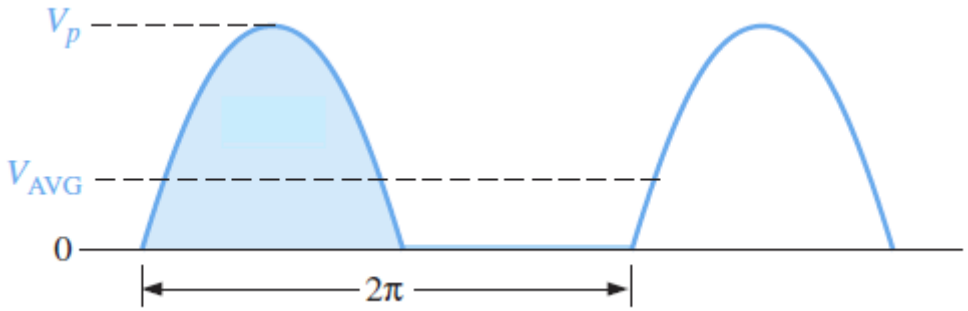


Polutalasni ispravljač sa idealnom diodom



Srednja vrednost napona

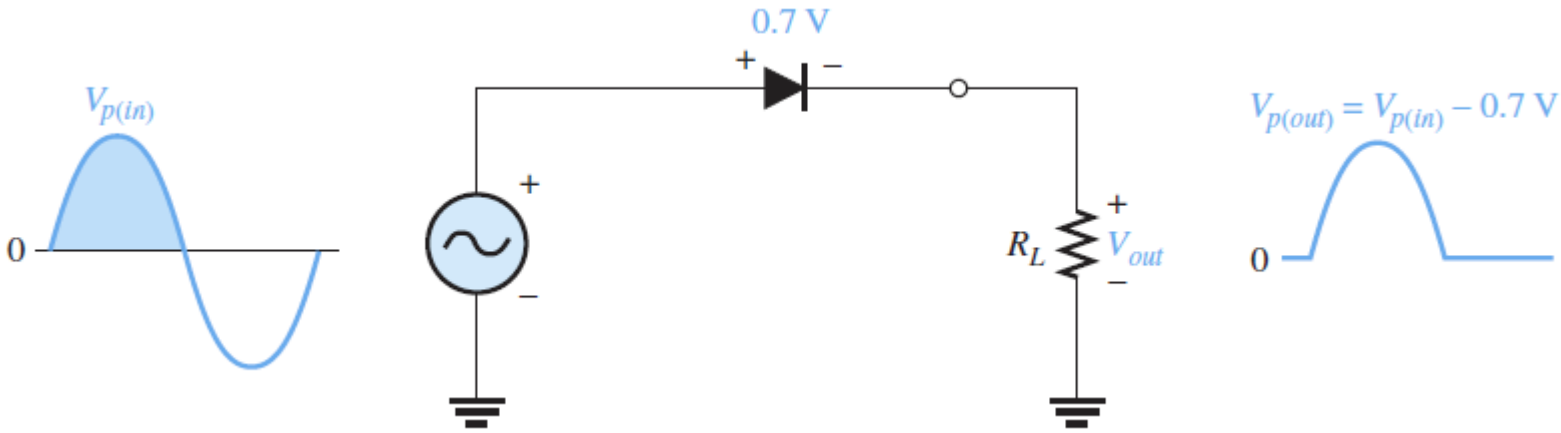


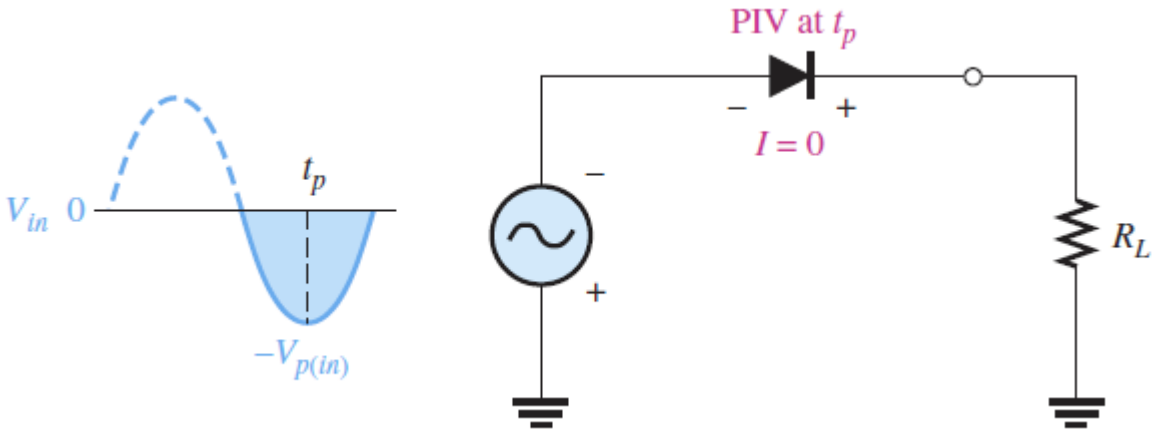


$$V_{AVG} = \frac{V_p}{\pi}$$

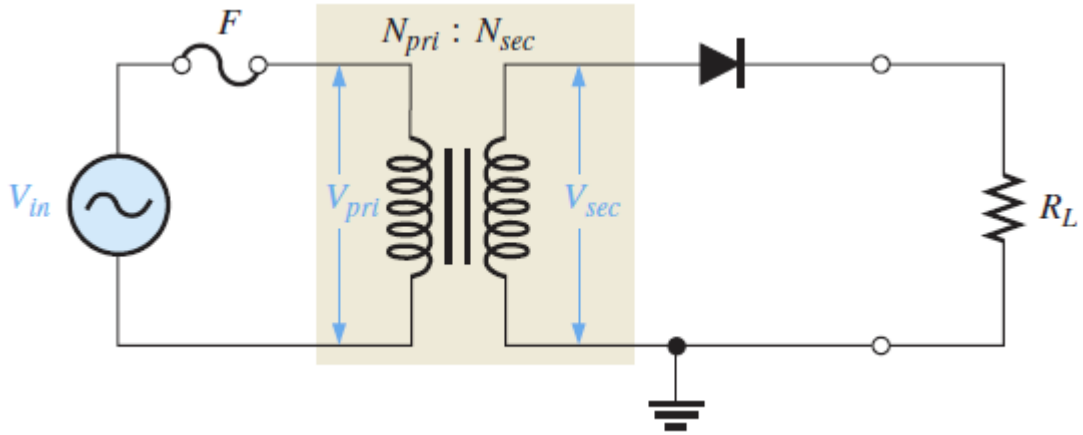
Polutalasni ispravljač sa realnom diodom

$$V_{p(out)} = V_{p(in)} - 0.7\,\text{V}$$





Povezivanje polutalasnog ispravljača sa transformatorom

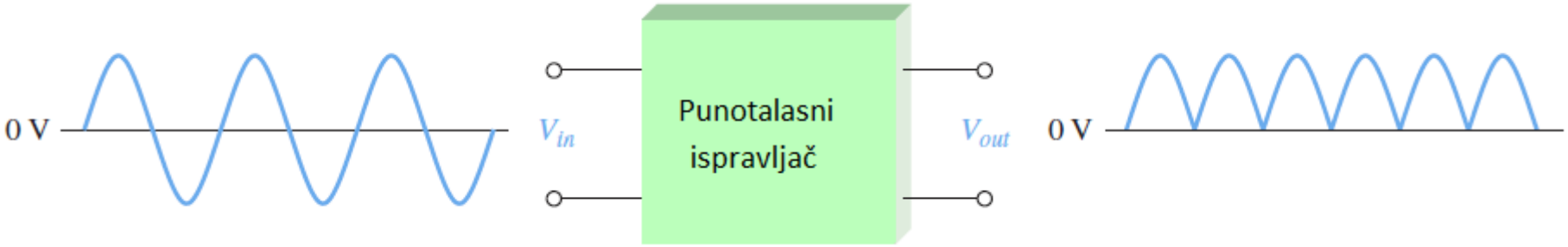


$$V_{sec} = nV_{pri}$$

$$V_{p(out)} = V_{p(sec)} - 0.7\ \text{V}$$

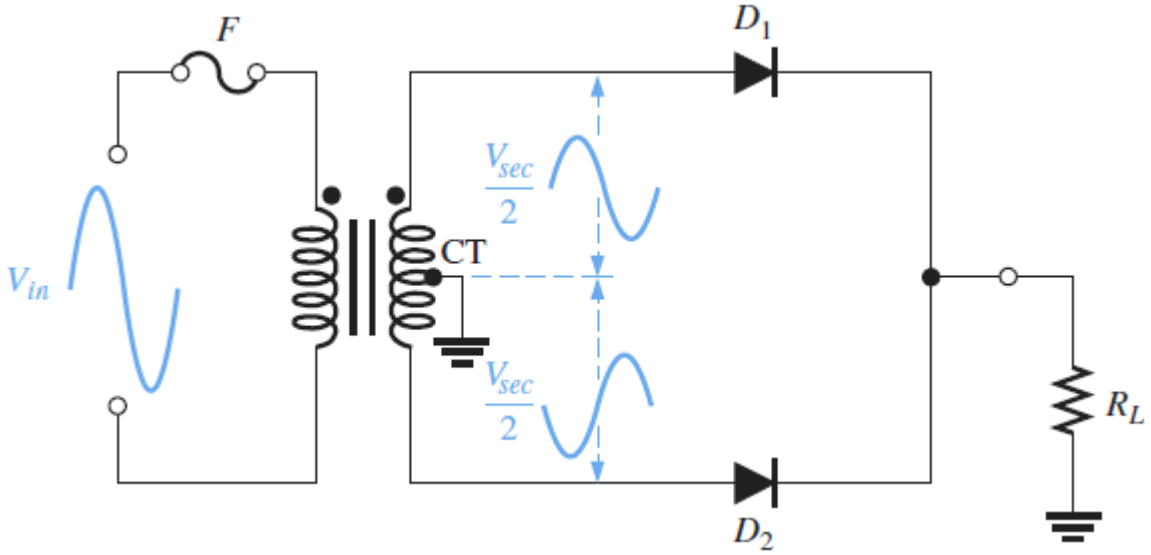
$$\text{PIV} = V_{p(sec)}$$

Punotalasni ispravljač sa idealnom diodom

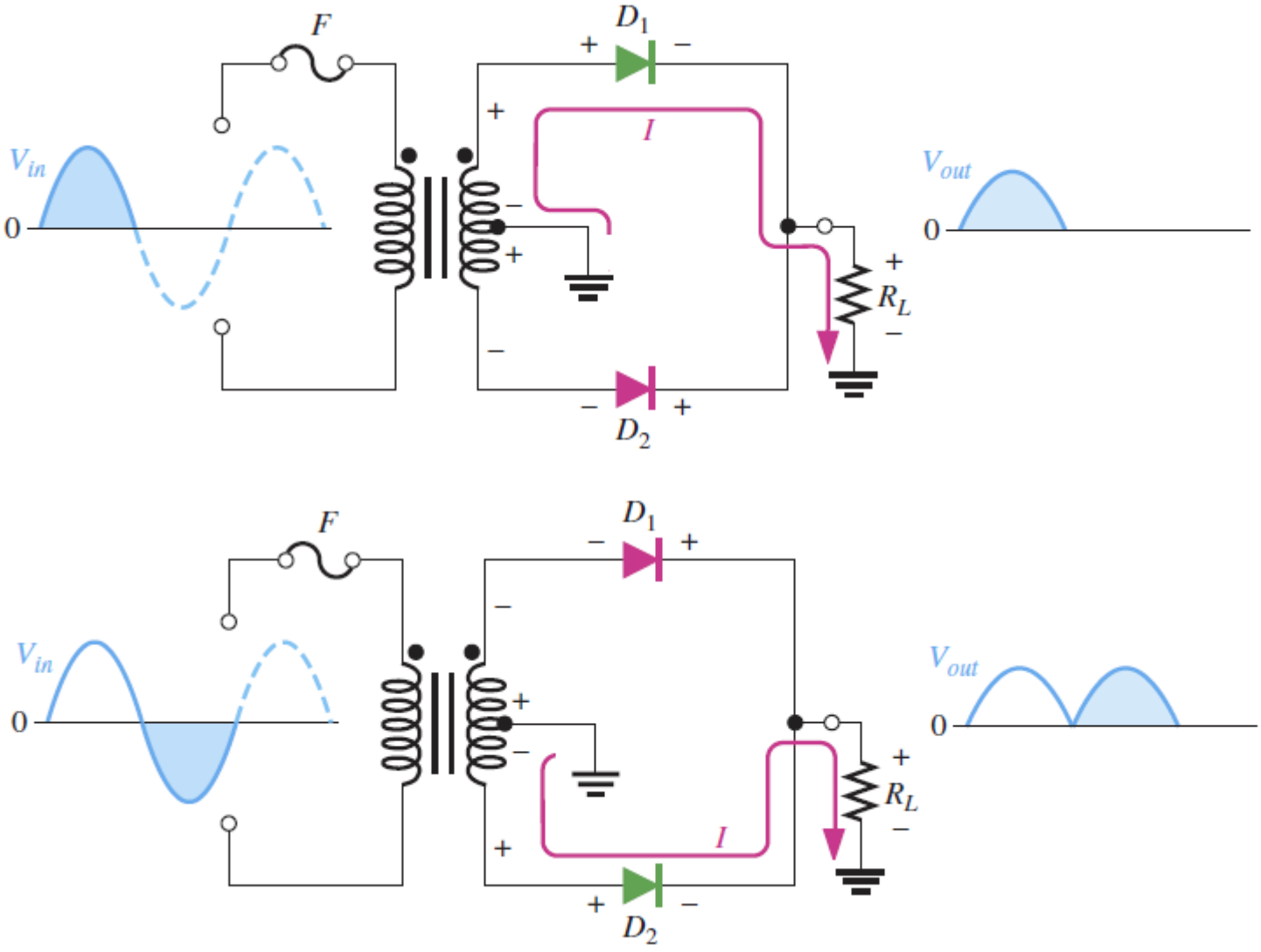


$$V_{AVG} = \frac{2V_p}{\pi}$$

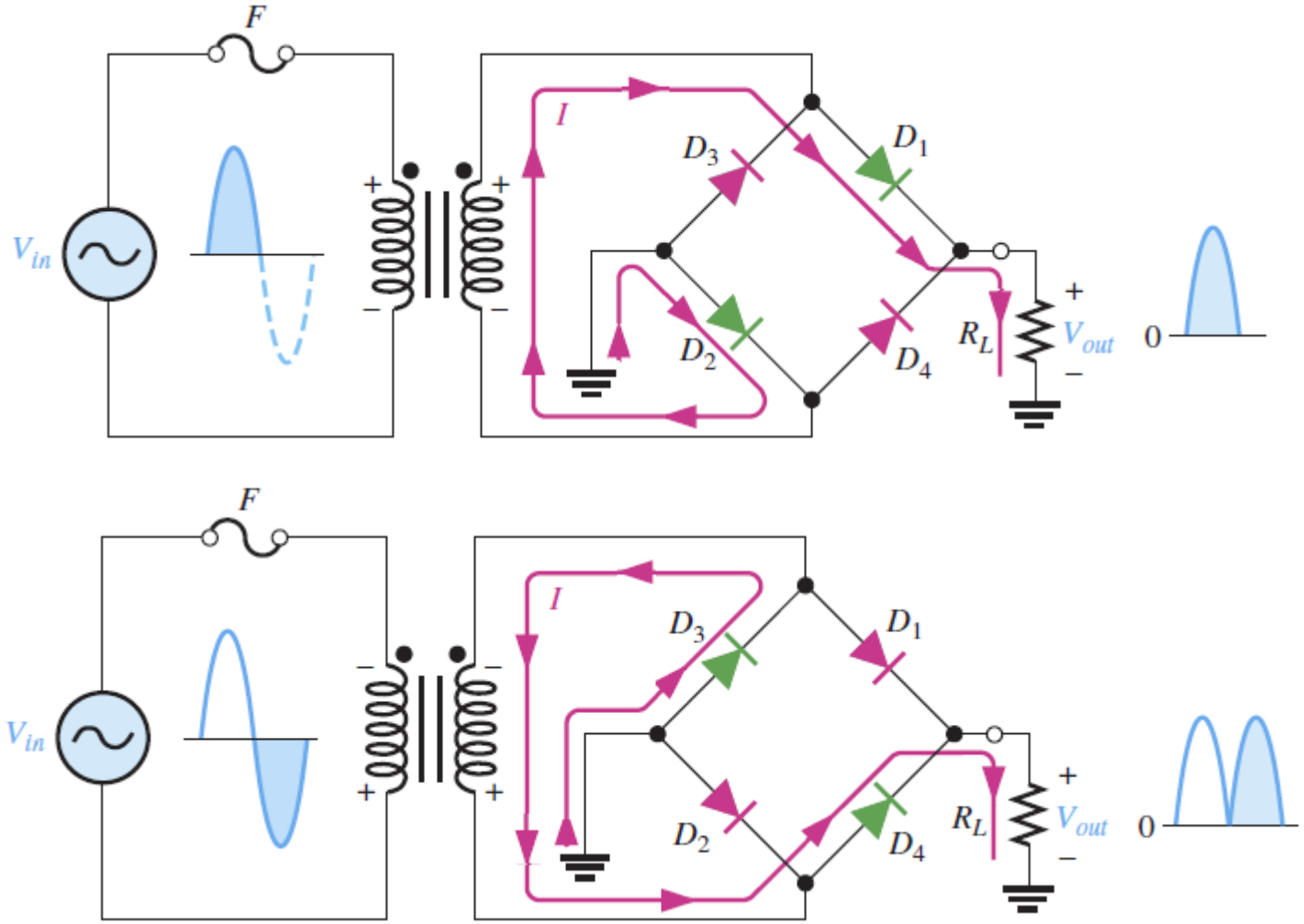
Punotalasni ispravljač sa idealnom diodom



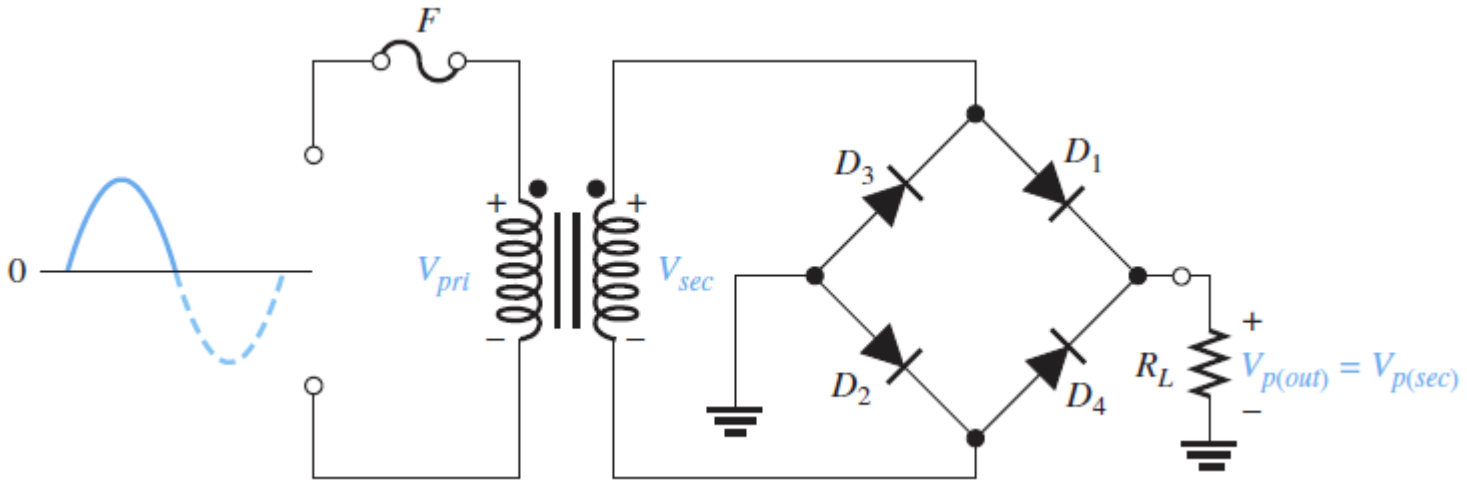
Punotalasni ispravljač sa idealnom diodom

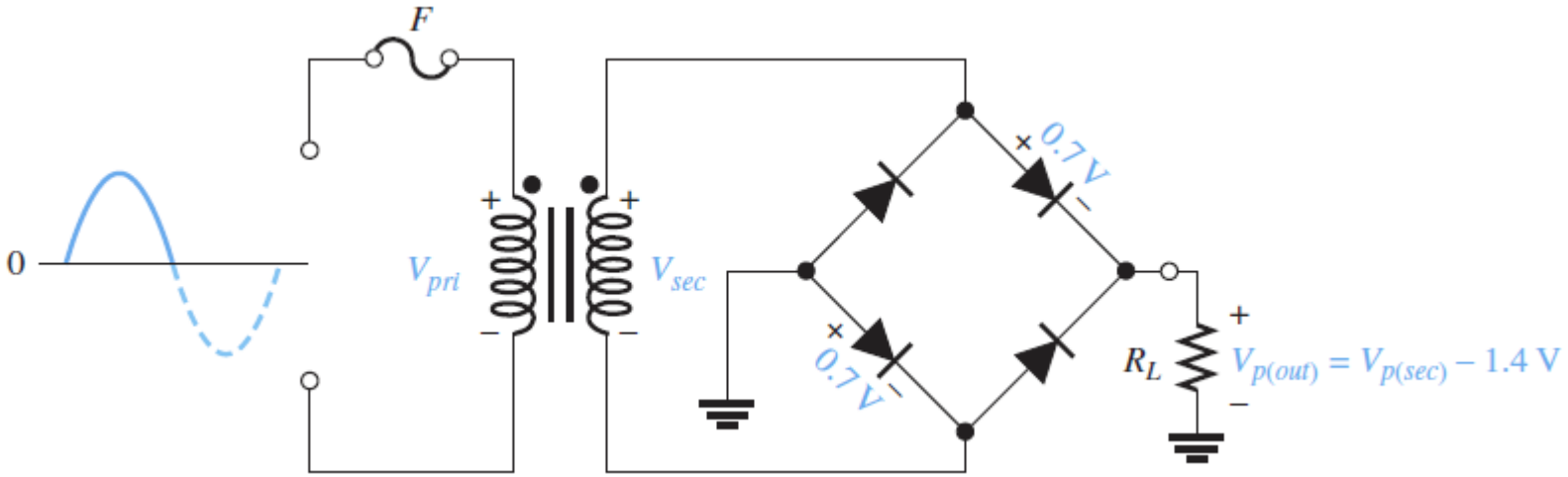


Mostni punotalasni ispravljač sa idealnom diodom

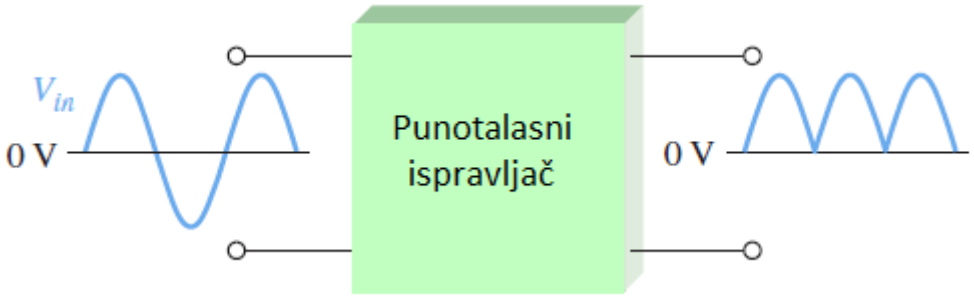


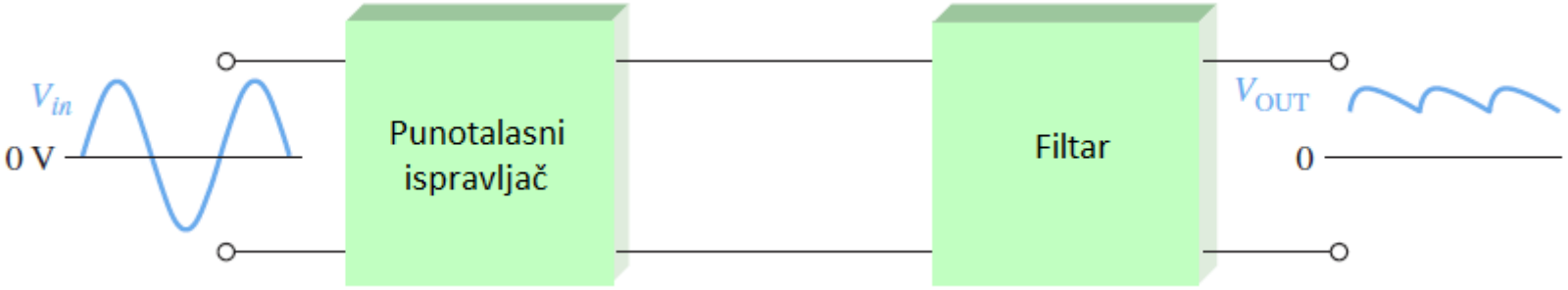
Maksimalni izlazni napon za idealne i za realne diode



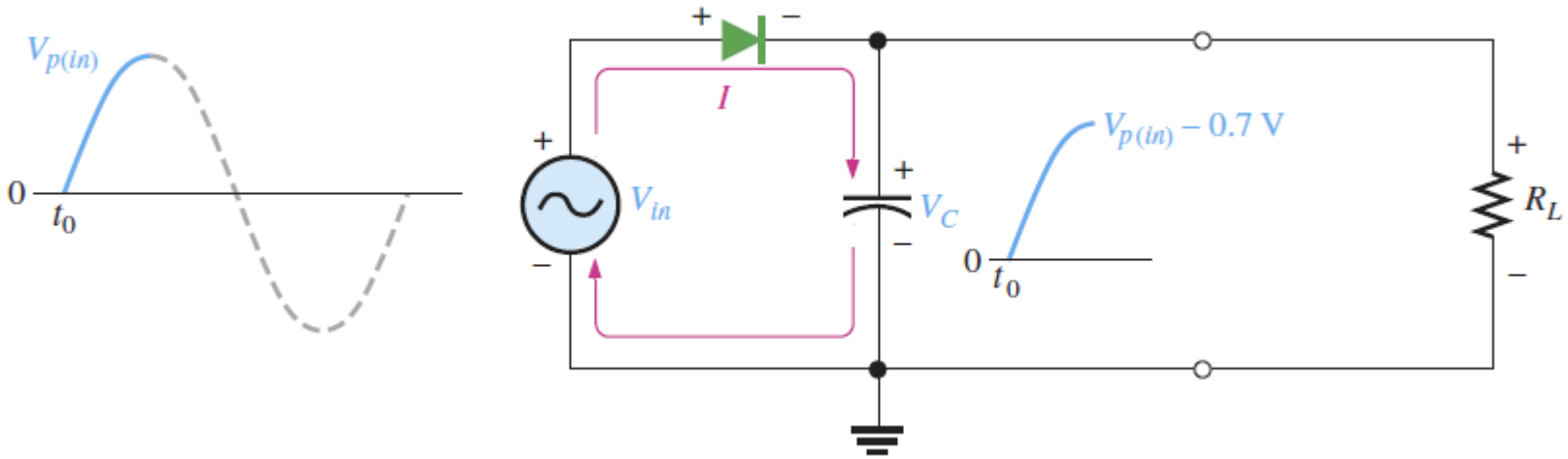


Filtriranje ispravljenog napona

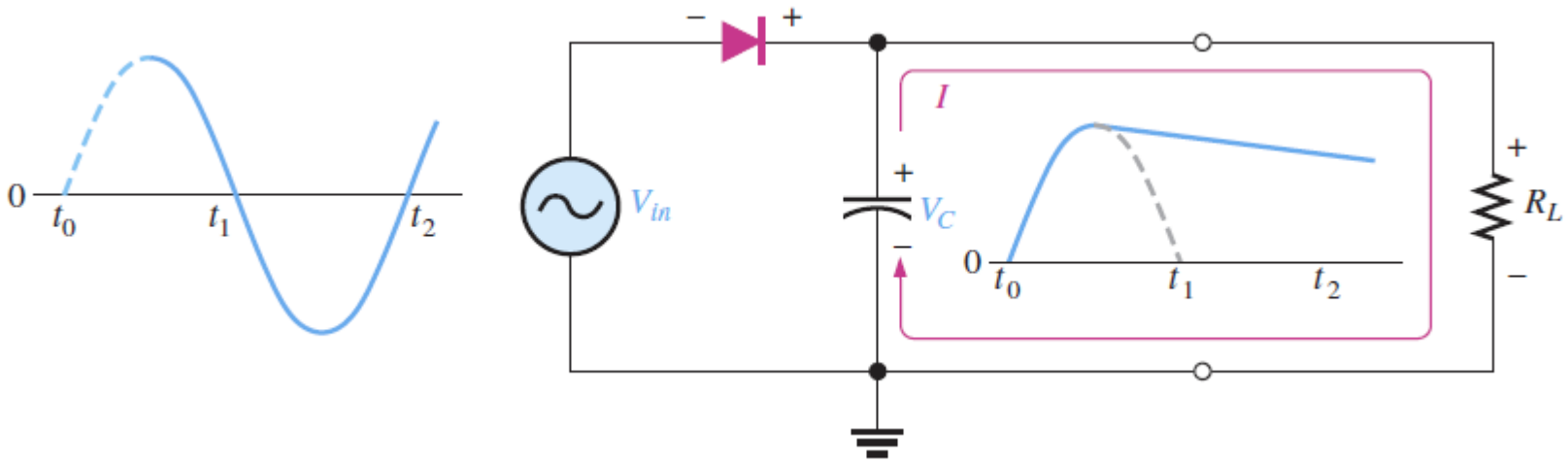




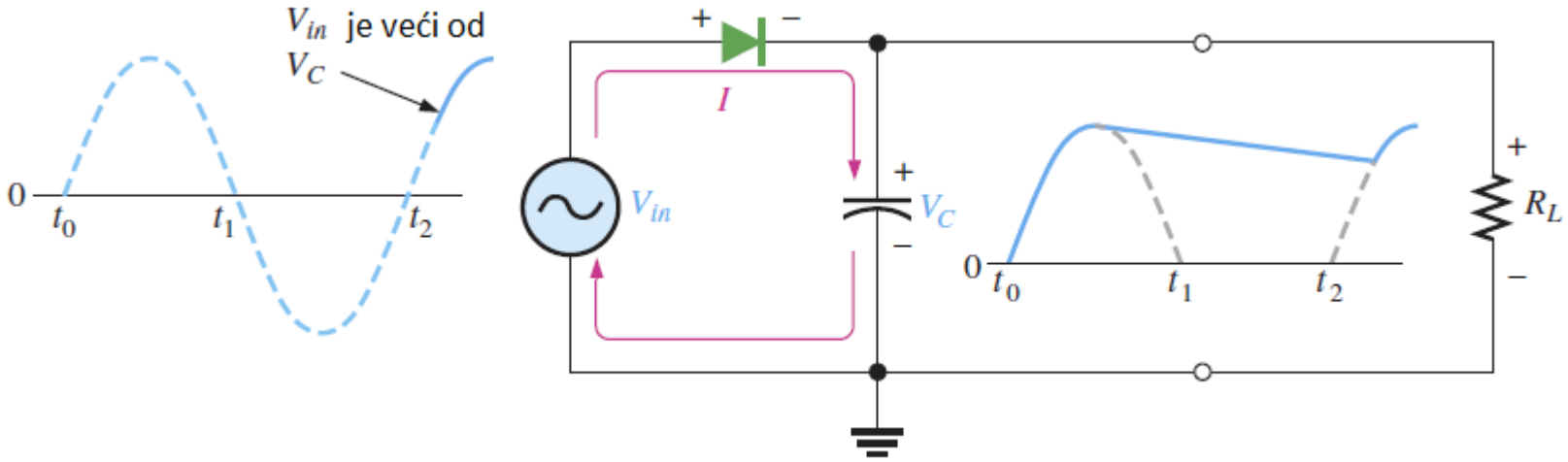
Prost kapacitivni filtar
punjenje kondenzatora



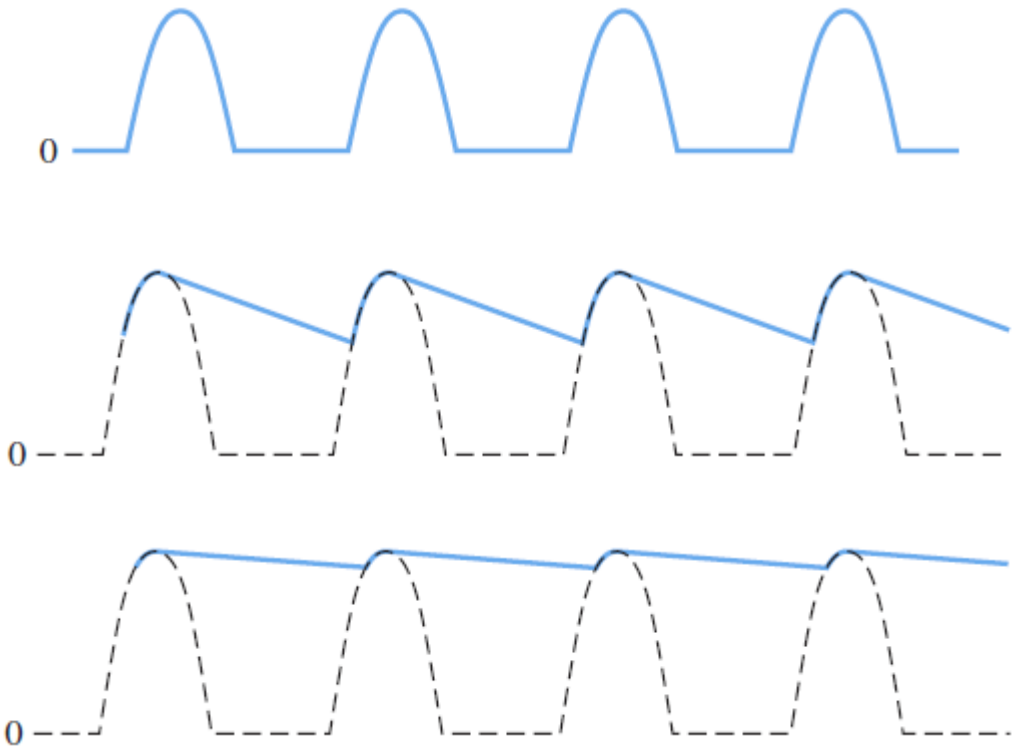
Prost kapacitivni filtar pražnjenje kondenzatora



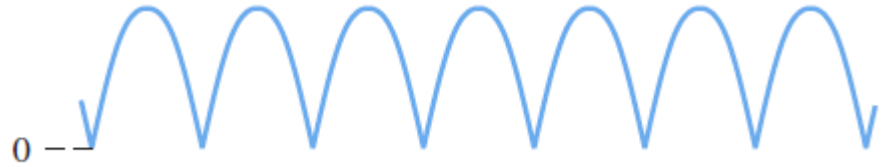
Prost kapacitivni filtar
naredno punjenje kondenzatora

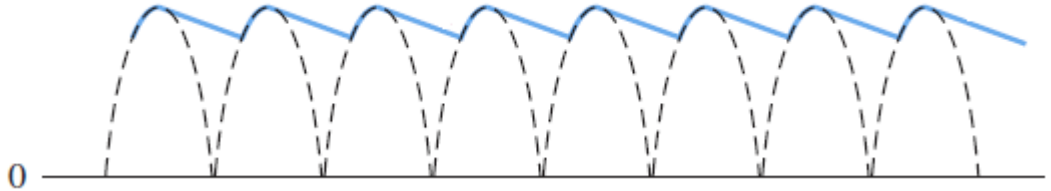


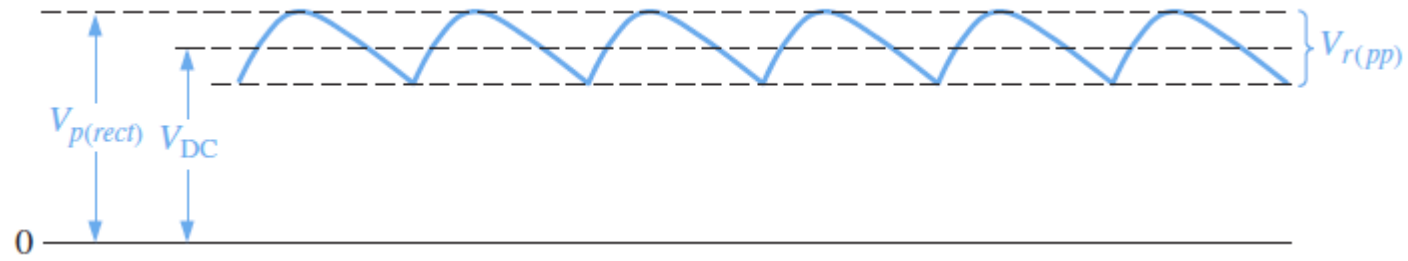
Talasnost ispravljenog napona polutalasnog ispravljača i prostog kapacitivnog filtra (ulaz, neefikasan i efikasan filtar)



Talasnost ispravljenog napona punotalasnog ispravljača i prostog kapacitivnog filtra (ulaz i filtrirani izlaz)





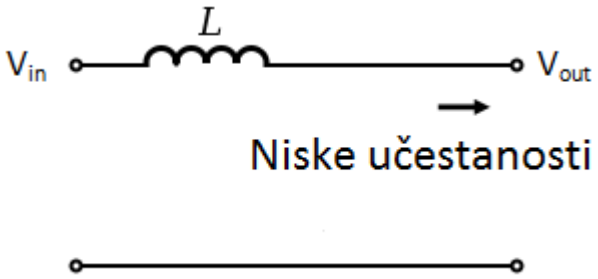


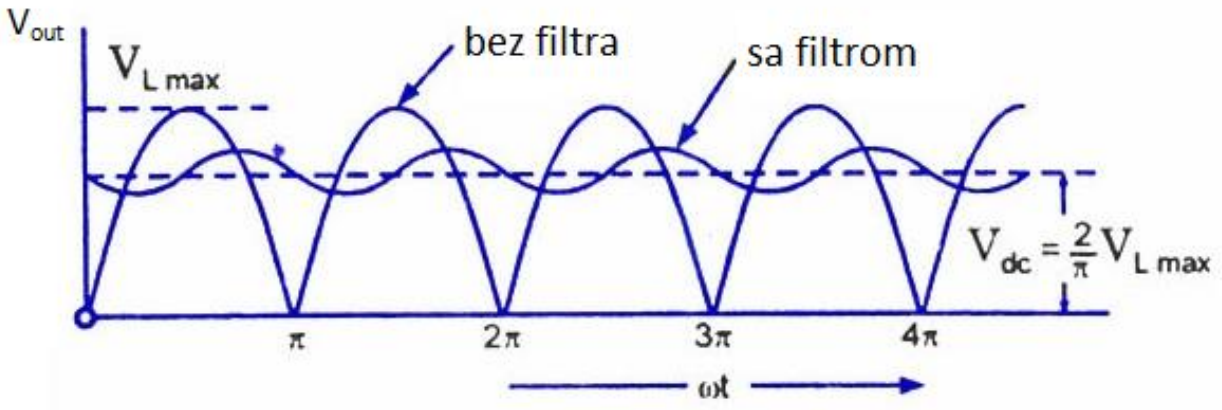
$$r = \frac{V_{r(pp)}}{V_{DC}}$$

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$

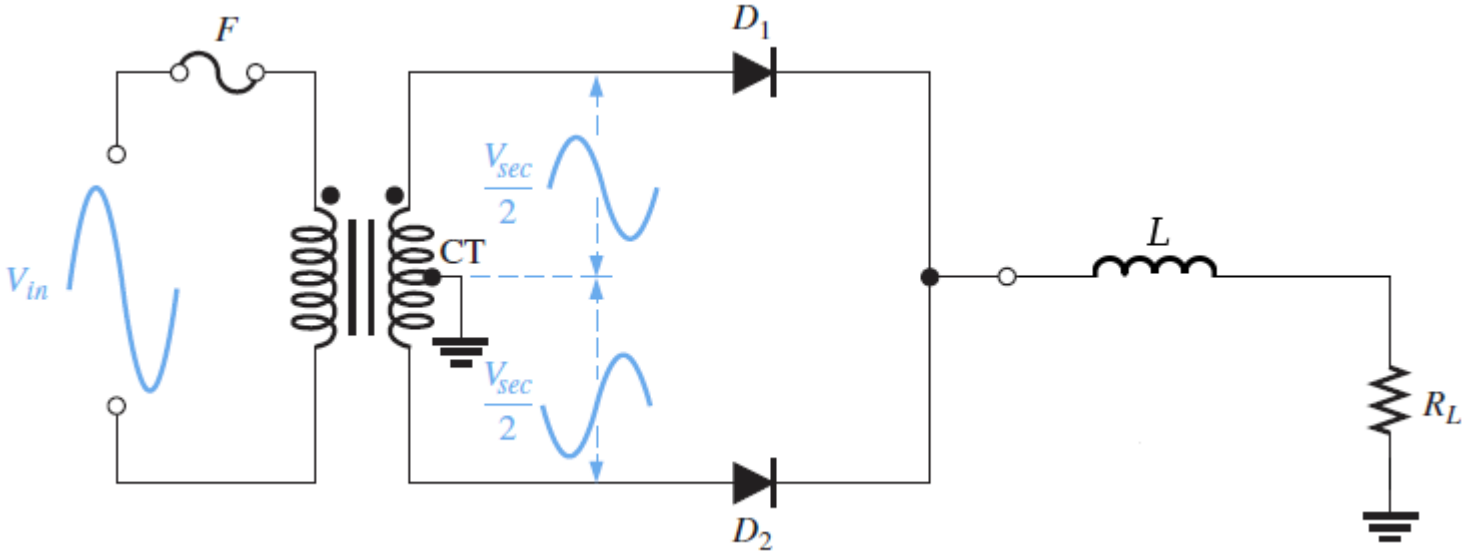
$$V_{DC} \cong \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$

Prost induktivni filtar

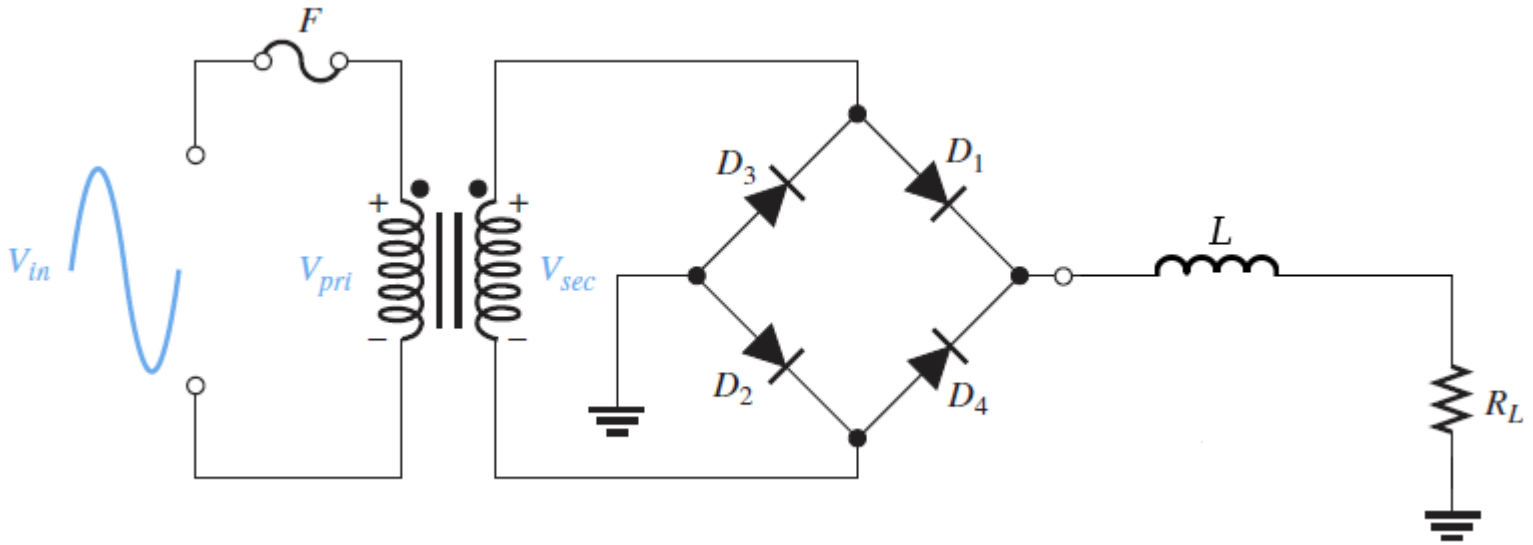




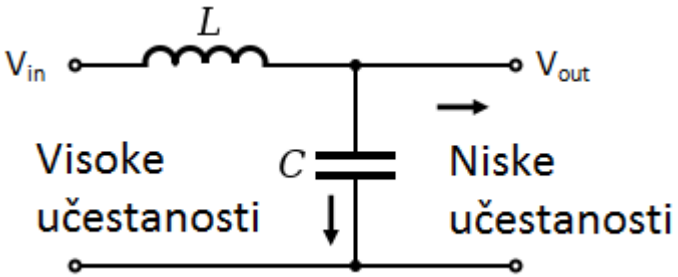
Punotalasni ispravljač sa prostim induktivnom filtrom

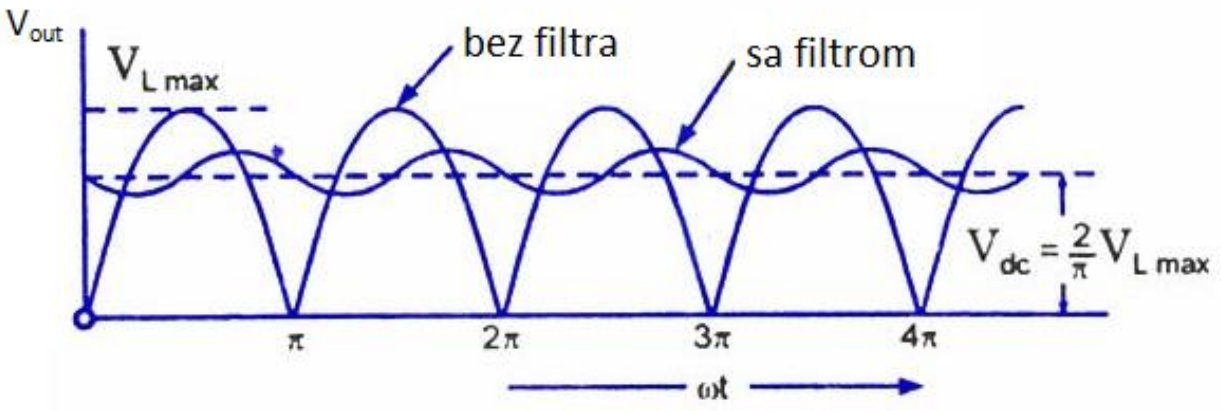


Punotalasni ispravljač sa prostim induktivnom filtrom

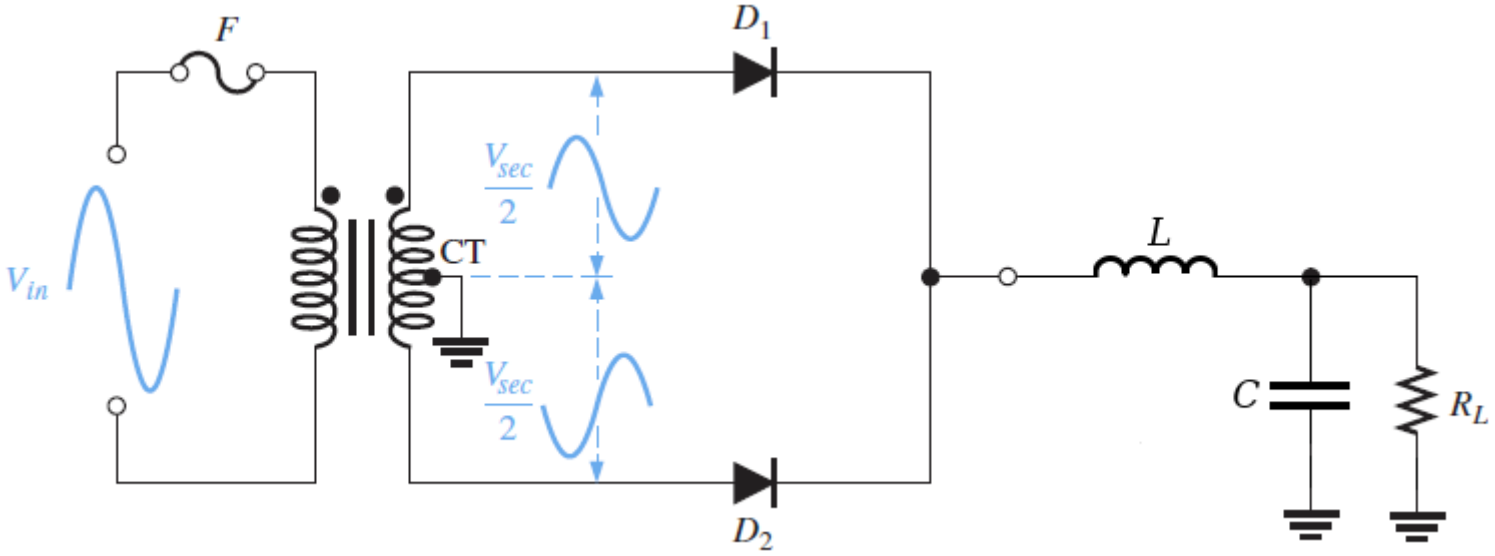


L filtar

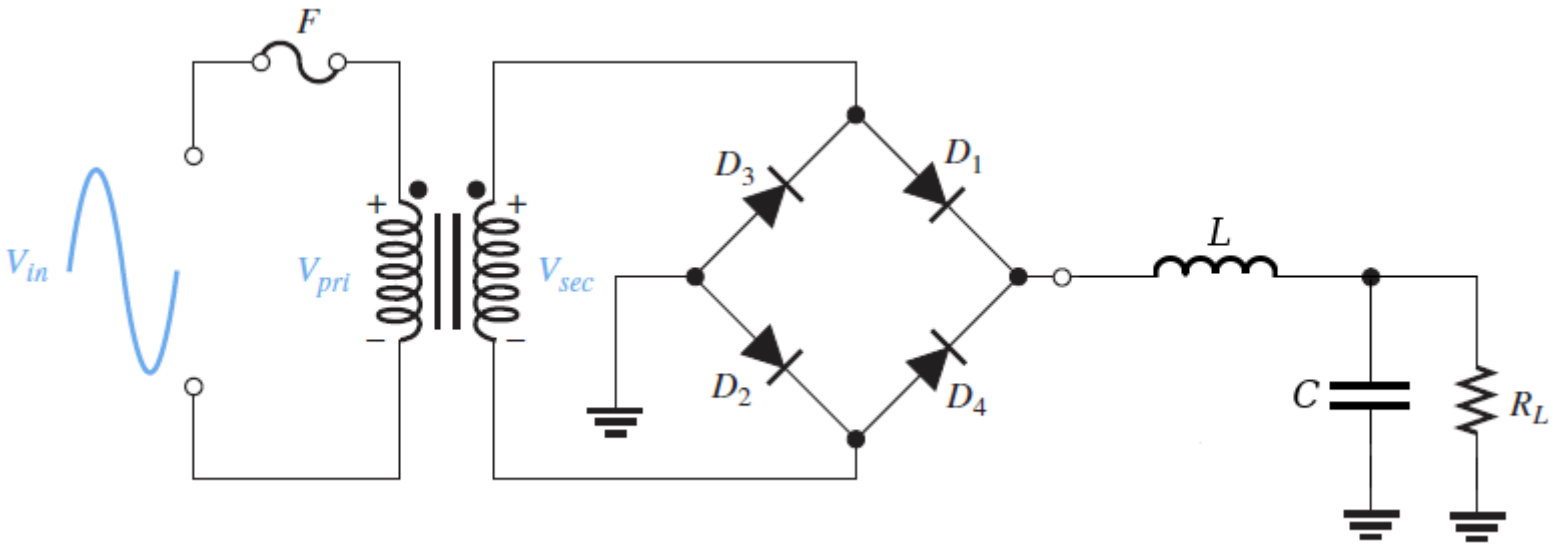

L
V_{in}
V_{out}
Visoke
učestanosti
C
Niske
učestanosti


V_{out}
$V_{L\,max}$
bez filtra
sa filtrom
$V_{dc} = \frac{2}{\pi} V_{L\,max}$
π
2π
3π
4π
ωt

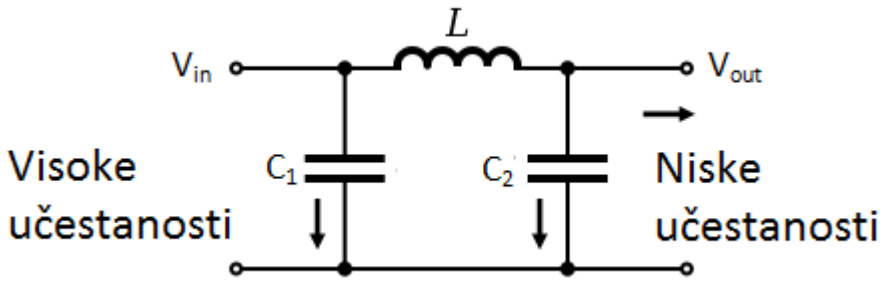
Punotalasni ispravljač sa L filtrom

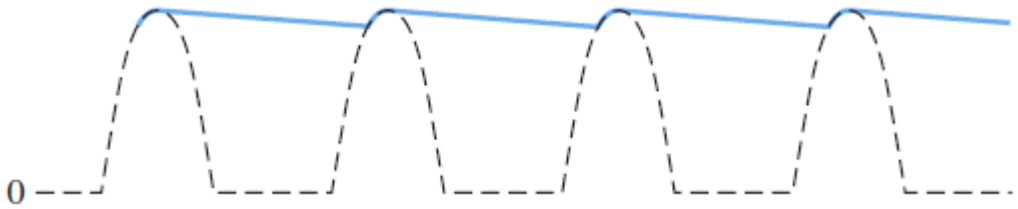


Punotalasni ispravljač sa L filtrom

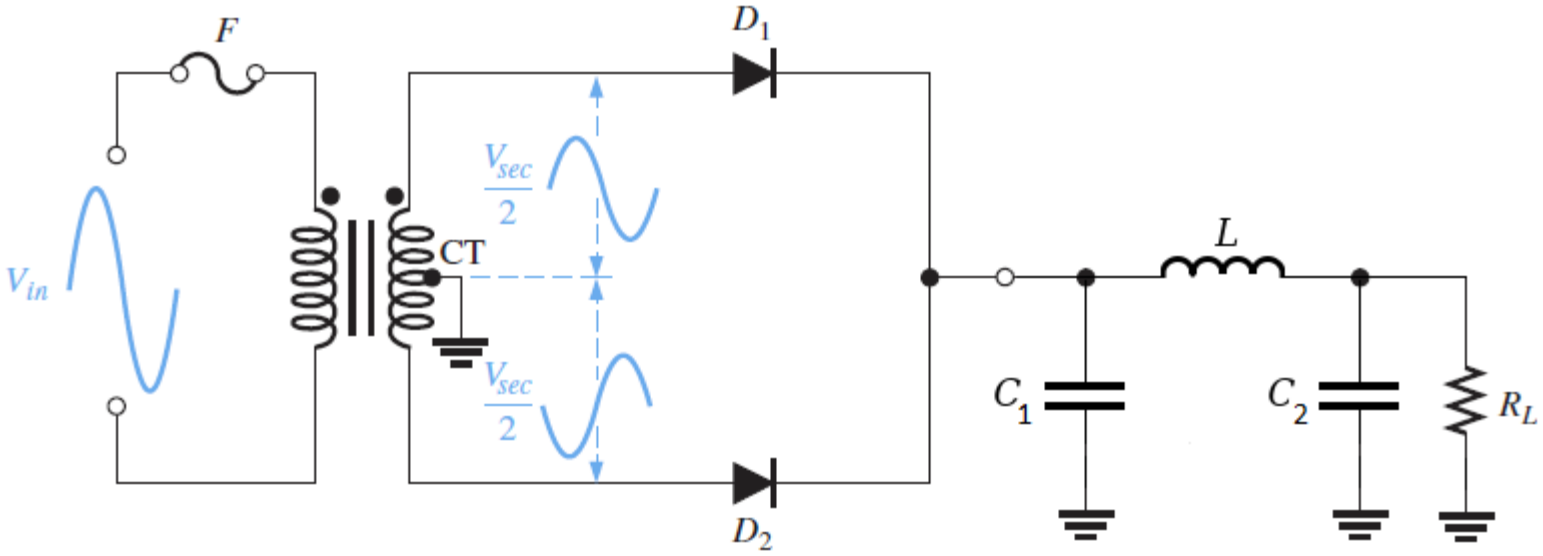


Π filtar

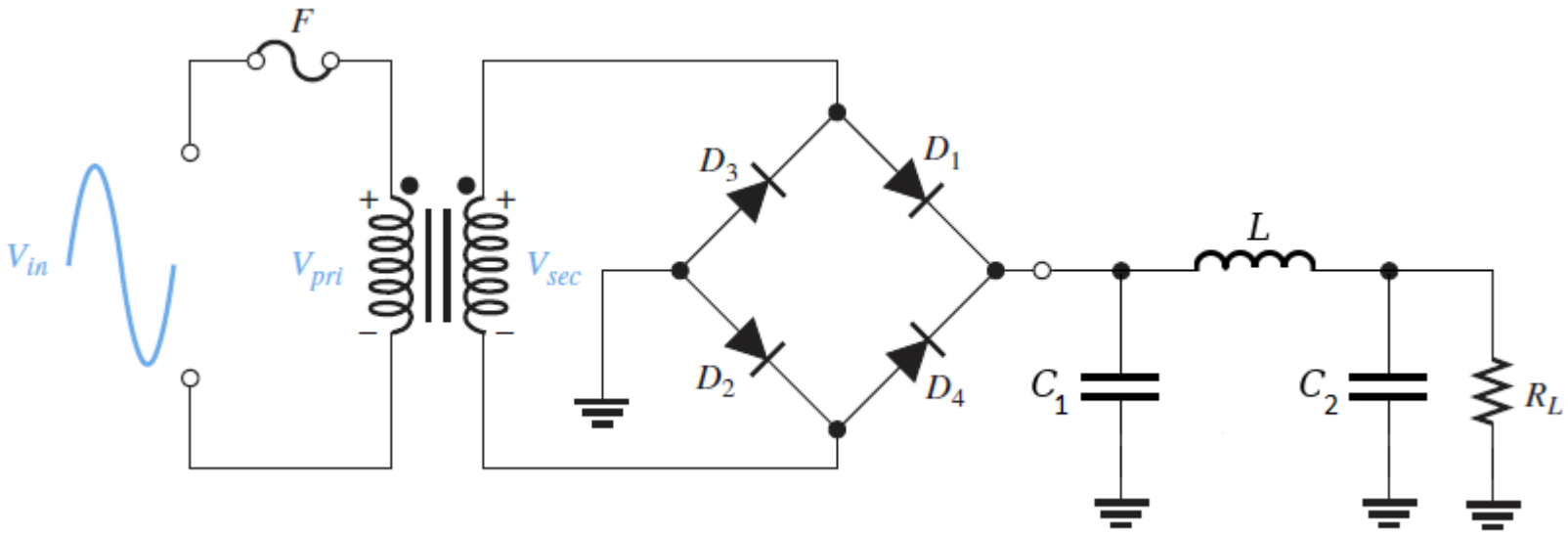




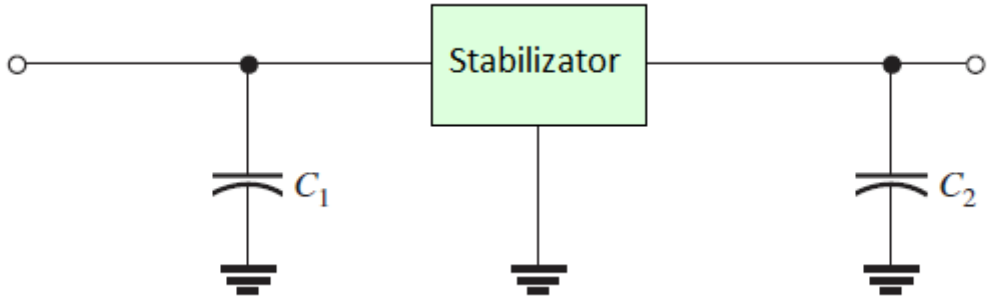
Punotalasni ispravljač sa Π filtrom

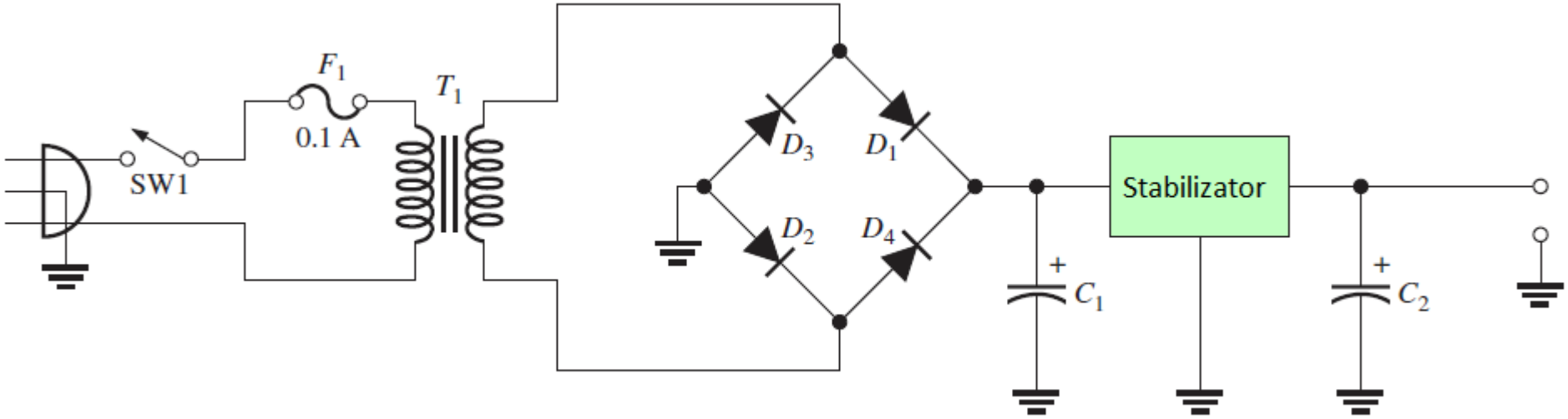


Punotalasni ispravljač sa Π filtrom

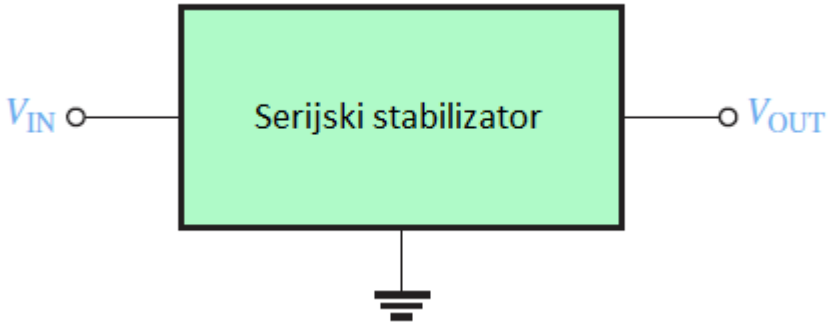


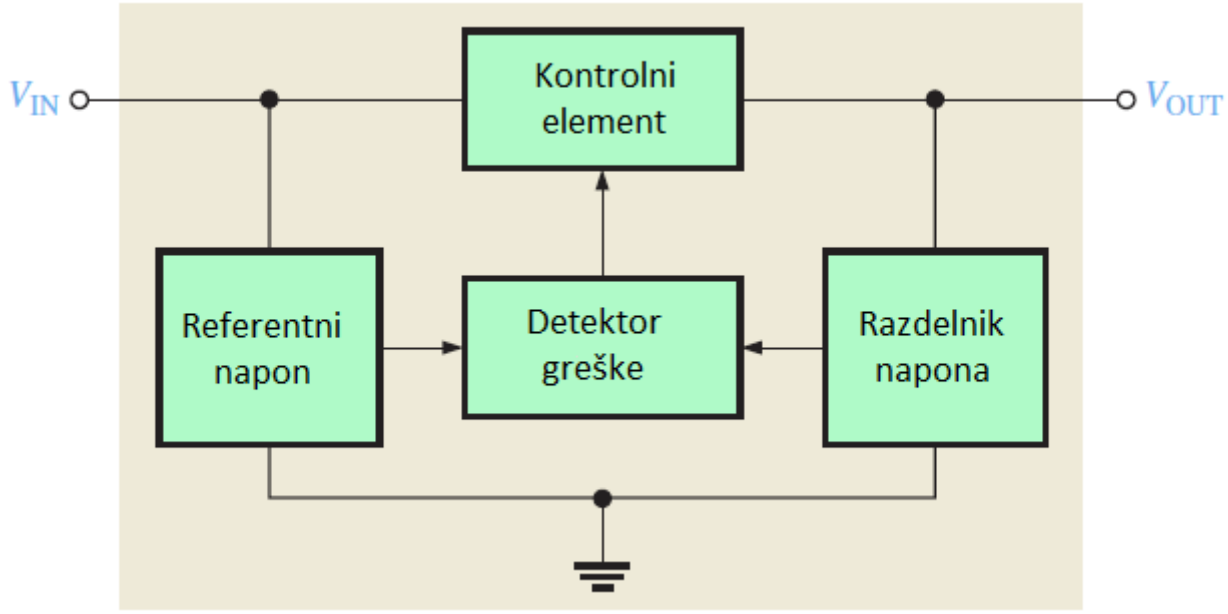
Serijski stabilizator napona



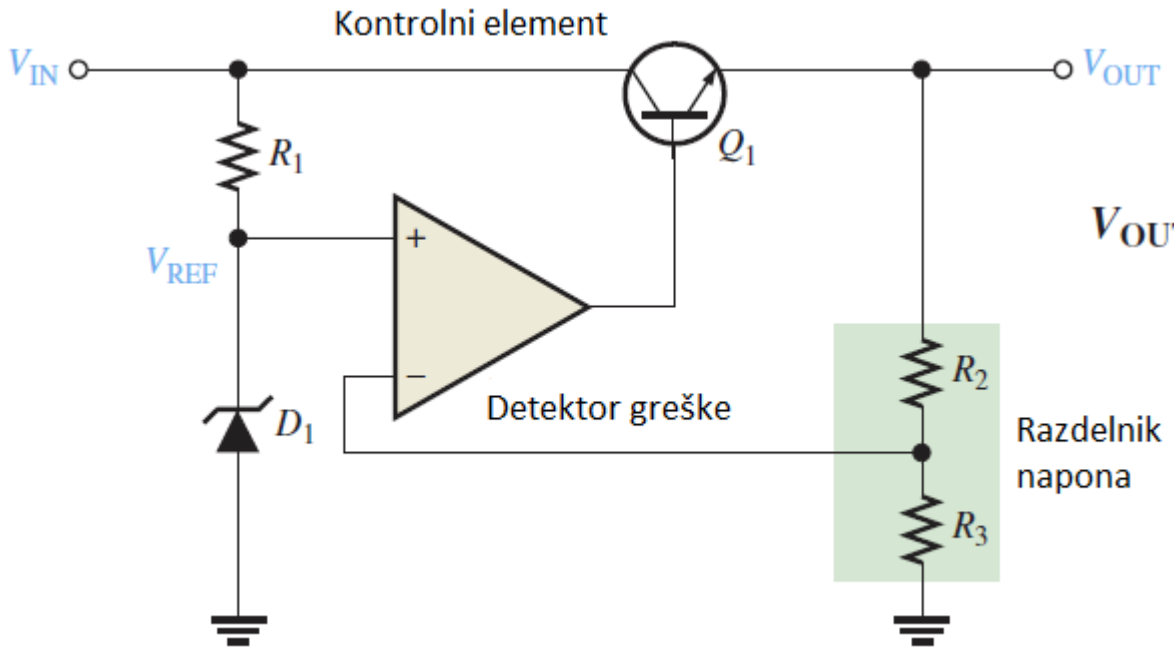


Serijski stabilizator napona blok dijagram



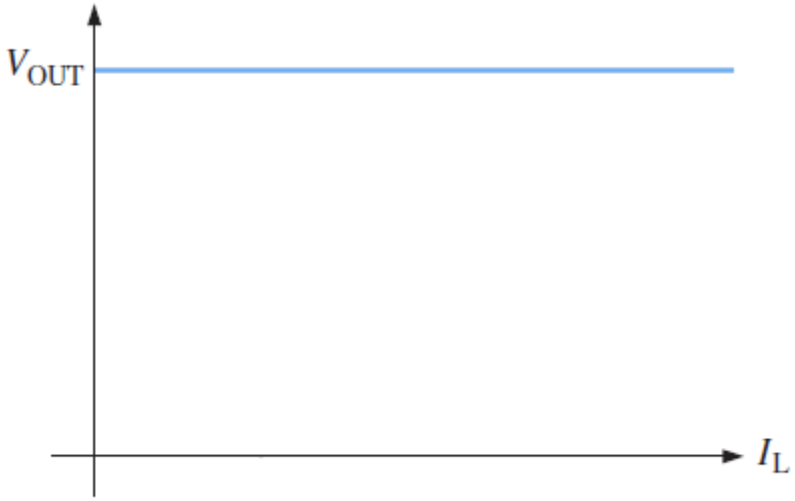


Serijski stabilizator napona osnovna električna šema kolo bez zaštite



$$V_{OUT} \cong \left(1 + \frac{R_2}{R_3}\right) V_{REF}$$

Serijski stabilizator napona strujno naponska karakteristika kola bez zaštite

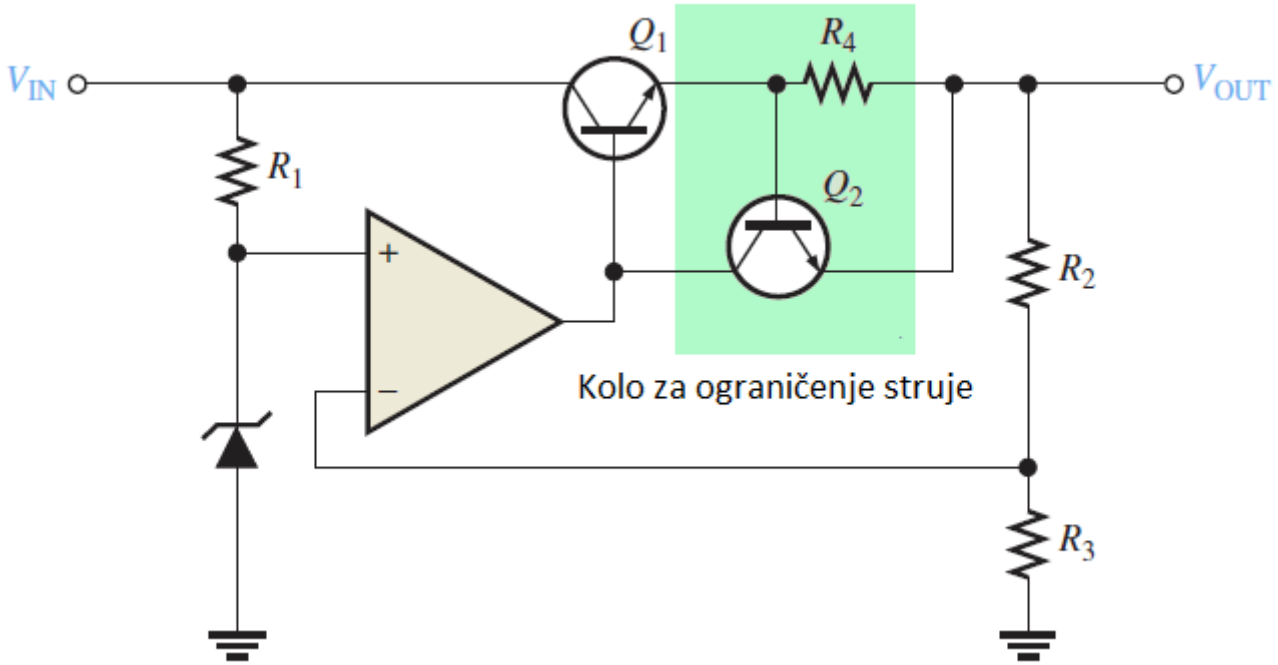


Karakteristika je parametarska, tj. tačka na karakteristici zavisi od otpornosti potrošača. Disipacija tranzistora za kratak spoj na izlazu je neograničena jer je struja u kratkom spoju neograničena.

$$P_D(I_{L(max)}) = V_{CE}I_C = (V_{IN} - V_{OUT})I_{L(max)}$$

$$P_D(I_{KS}) = V_{CE}I_C = V_{IN}I_{KS}$$

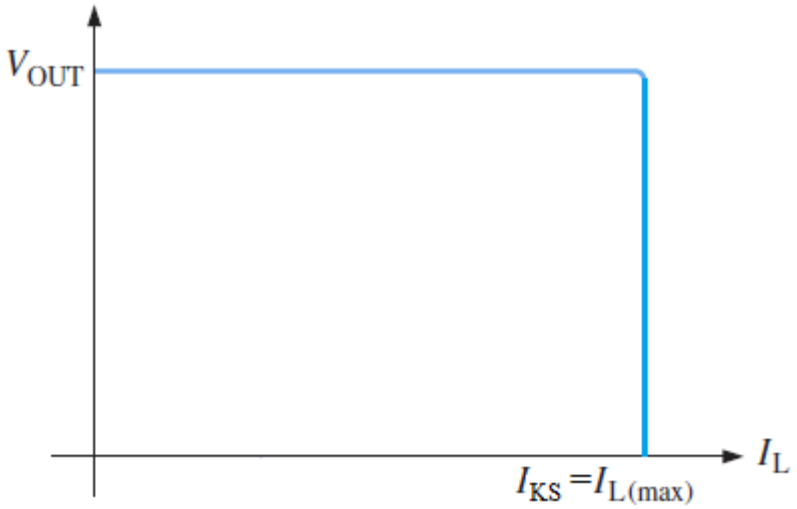
Serijski stabilizator napona električna šema sa prekostrujnom zaštitom



$$V_{OUT} \cong \left(1 + \frac{R_2}{R_3}\right) V_{REF}$$

$$I_{L(max)} = \frac{0.7\ \text{V}}{R_4}$$

Serijski stabilizator napona strujno naponska karakteristika prekostrujne zaštite

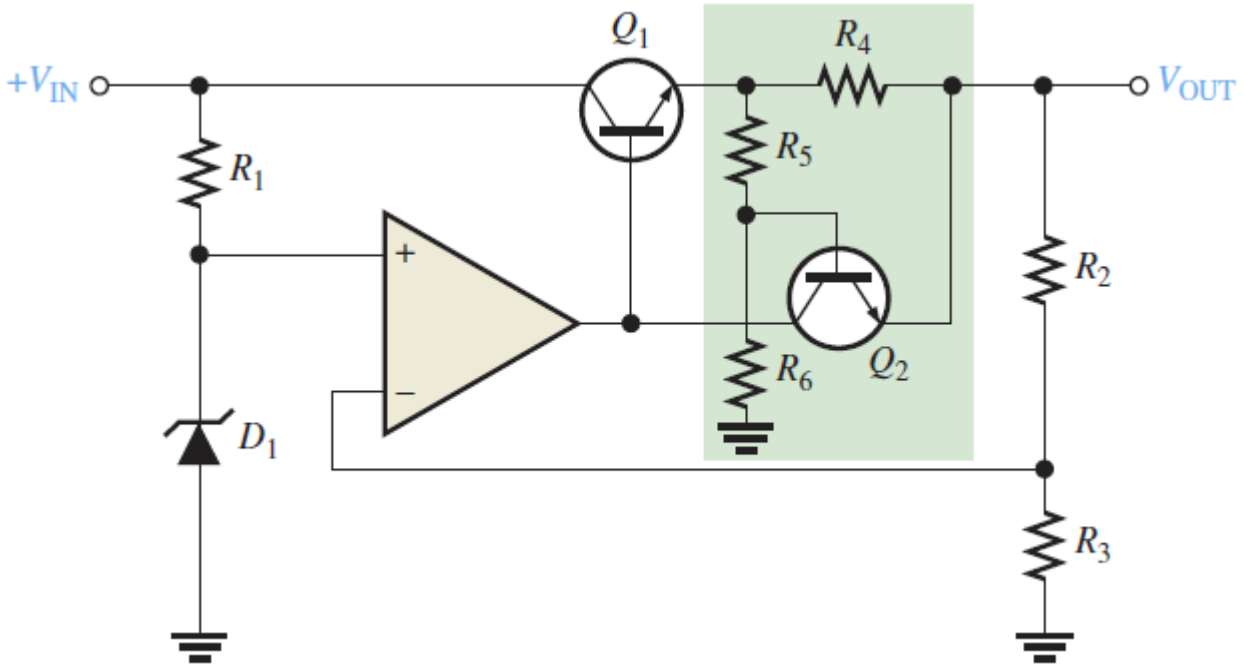


Disipacija tranzistora za kratak spoj na izlazu je znatno veća od disipacije pri maksimalnoj struji.

$$P_D(I_{L(max)}) = V_{CE}I_C = (V_{IN} - V_{OUT})I_{L(max)} \qquad P_D(I_{KS}) = V_{CE}I_C = V_{IN}I_{KS}$$

$$\frac{P_D(I_{KS})}{P_D(I_{L(max)})} = \frac{V_{IN}I_{KS}}{(V_{IN} - V_{OUT})I_{L(max)}} = \frac{V_{IN}}{V_{IN} - V_{OUT}} = \frac{1}{1 - \frac{V_{OUT}}{V_{IN}}} > 1$$

Serijski stabilizator napona električna šema sa presavijenom ("foldback") zaštitom



$$V_{OUT} \cong \left(1 + \frac{R_2}{R_3}\right) V_{REF}$$

$$I_{L(max)} = \frac{0.7\ \text{V}}{R_4}$$

Serijski stabilizator napona formule karakteristika pri radu presavijene ("foldback") zaštite

$$V_{E1} = V_{OUT} + R_4 I_L$$

$$V_{B2} = \frac{R_6}{R_6 + R_5} V_{E1}$$

$$V_{E2} = V_{OUT}$$

$$V_{BE2} = V_{B2} - V_{E2}$$

$$V_{BE2} = \frac{R_6}{R_6 + R_5}(V_{OUT} + R_4 I_L) - V_{OUT}$$

$$V_{BE2} = \frac{R_6}{R_6 + R_5} R_4 I_L - \frac{R_5}{R_6 + R_5} V_{OUT}$$

$$\frac{R_5}{R_6 + R_5} V_{OUT} = \frac{R_6}{R_6 + R_5} R_4 I_L - V_{BE2}$$

$$V_{OUT} = \frac{R_6}{R_5} R_4 I_L - \frac{R_6 + R_5}{R_5} V_{BE2}$$

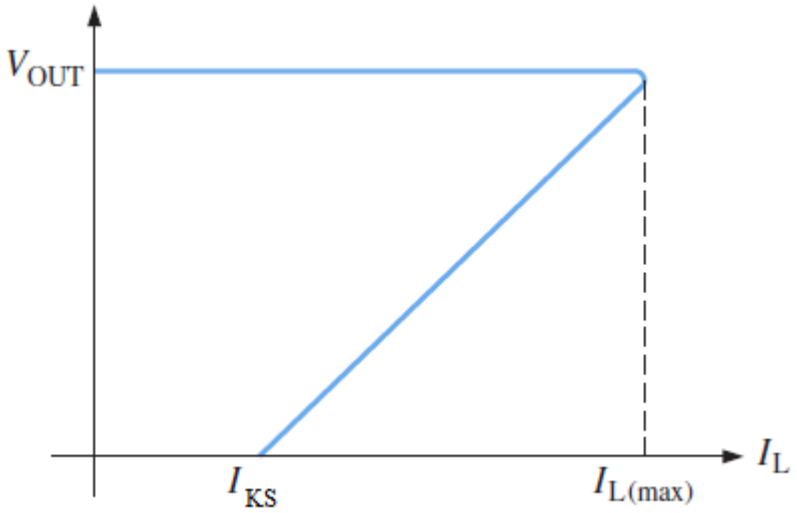
$$0 = \frac{R_6}{R_5} R_4 I_{KS} - \frac{R_6 + R_5}{R_5} V_{BE2}$$

$$I_{KS} = \frac{R_6 + R_5}{R_6} \frac{V_{BE2}}{R_4}$$

$$\frac{R_6 + R_5}{R_5} V_{BE2} = \frac{R_6}{R_5} R_4 I_{KS}$$

$$V_{OUT} = \frac{R_6}{R_5} R_4 (I_L - I_{KS})$$

Serijski stabilizator napona strujno naponska karakteristika presavijene ("foldback") zaštite

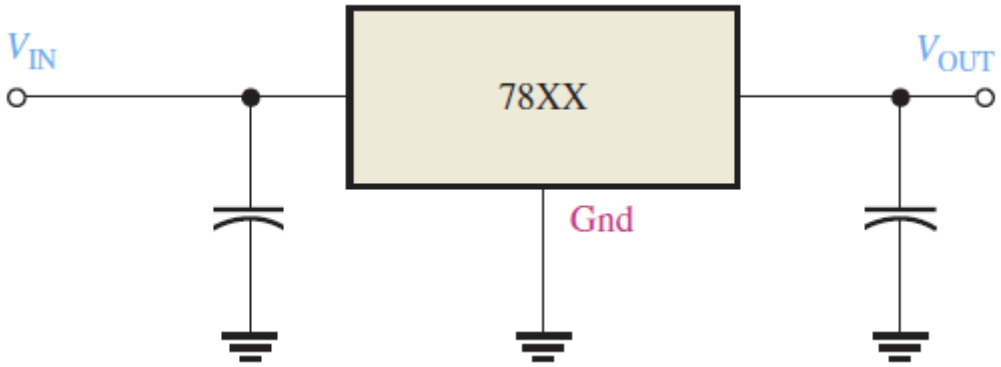


Disipacija tranzistora za kratak spoj na izlazu može biti proizvoljno puta manja od disipacije pri maksimalnoj struji.

$$P_D(I_{L(max)}) = V_{CE}I_C = (V_{IN} - V_{OUT})I_{L(max)} \qquad P_D(I_{KS}) = V_{CE}I_C = V_{IN}I_{KS}$$

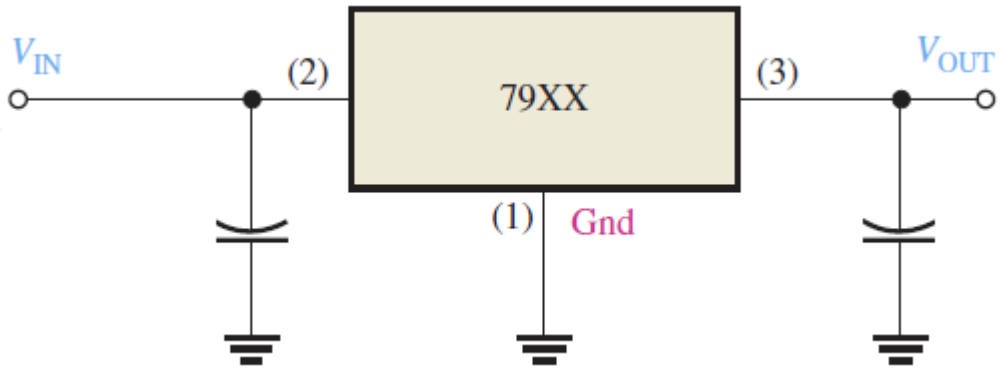
$$\frac{P_D(I_{KS})}{P_D(I_{L(max)})} = \frac{V_{IN}I_{KS}}{(V_{IN} - V_{OUT})I_{L(max)}} = \frac{\frac{I_{KS}}{I_{L(max)}}}{1 - \frac{V_{OUT}}{V_{IN}}} < 1$$

Serijski stabilizator pozitivnog napona



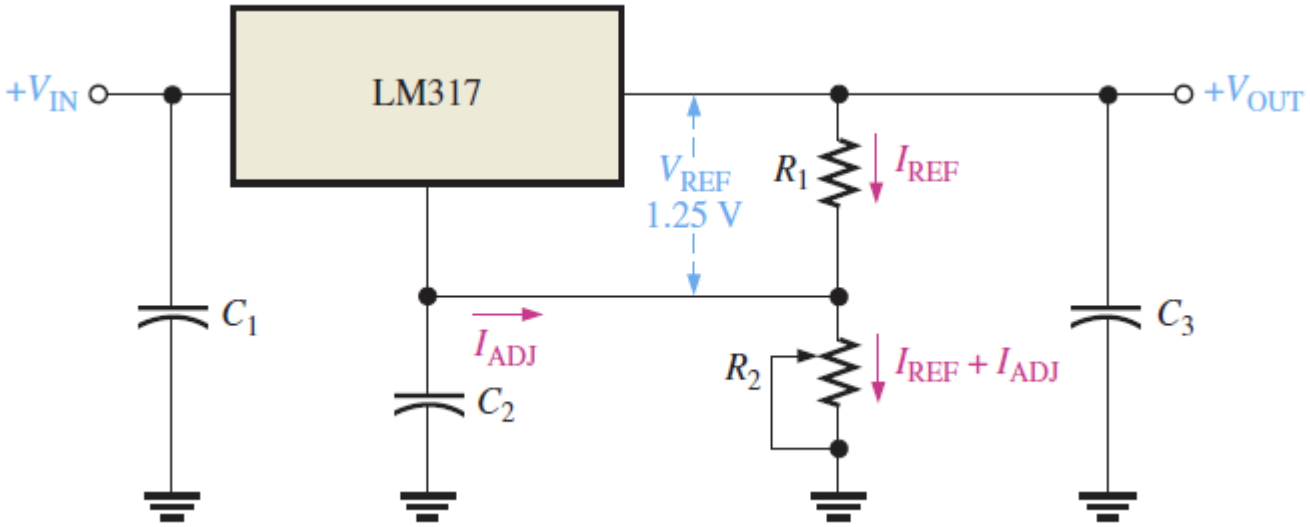
Oznaka	Izlazni napon
7805	+5.0 V
7806	+6.0 V
7808	+8.0 V
7809	+9.0 V
7812	+12.0 V
7815	+15.0 V
7818	+18.0 V
7824	+24.0 V

Serijski stabilizator negativnog napona



Oznaka	Izlazni napon
7905	–5.0 V
7905.2	–5.2 V
7906	–6.0 V
7908	–8.0 V
7912	–12.0 V
7915	–15.0 V
7918	–18.0 V
7924	–24.0 V

Serijski stabilizator napona sa promenljivim naponom



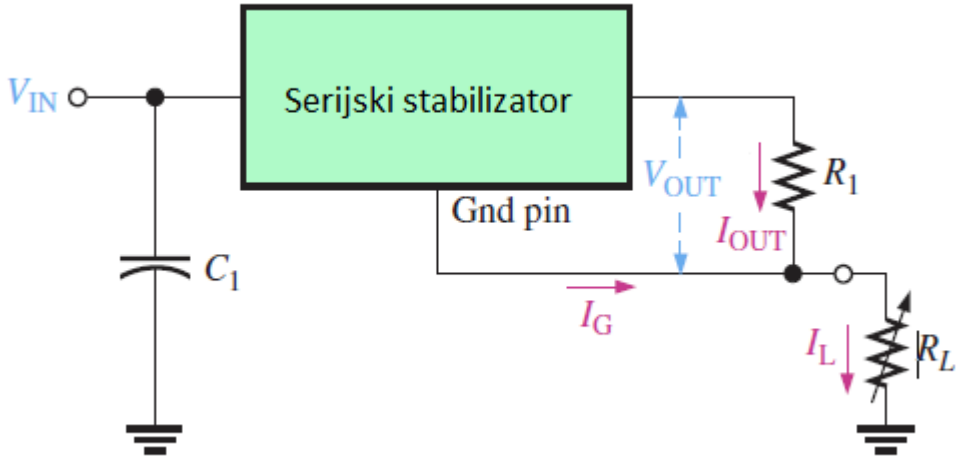
$$I_{REF} = \frac{V_{REF}}{R_1} = \frac{1.25\ \text{V}}{R_1}$$

$$V_{OUT} = V_{R1} + V_{R2} = I_{REF}R_1 + I_{REF}R_2 + I_{ADJ}R_2$$

$$V_{OUT} = I_{REF}(R_1 + R_2) + I_{ADJ}R_2 = \frac{V_{REF}}{R_1}(R_1 + R_2) + I_{ADJ}R_2$$

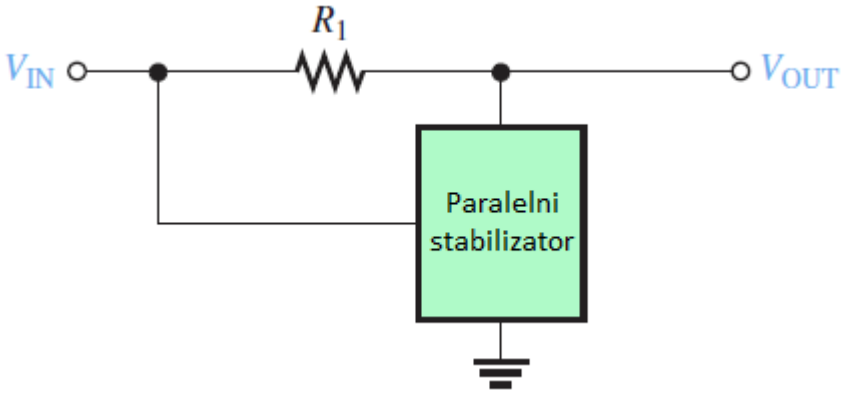
$$V_{OUT} = V_{REF}\left(1 + \frac{R_2}{R_1}\right) + I_{ADJ}R_2$$

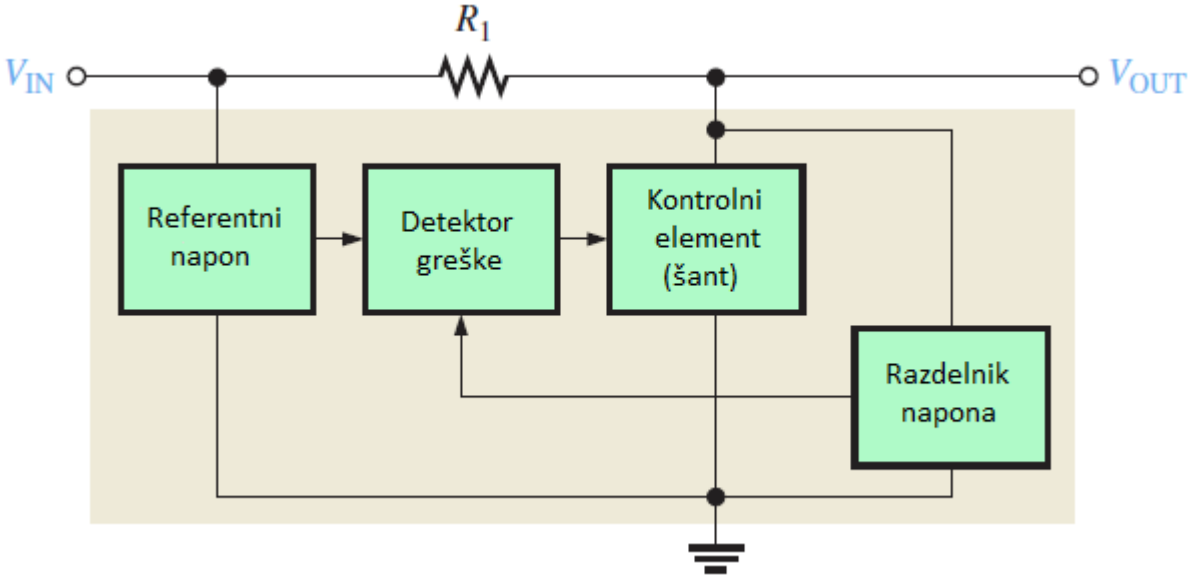
Serijski stabilizator napona kao strujni izvor



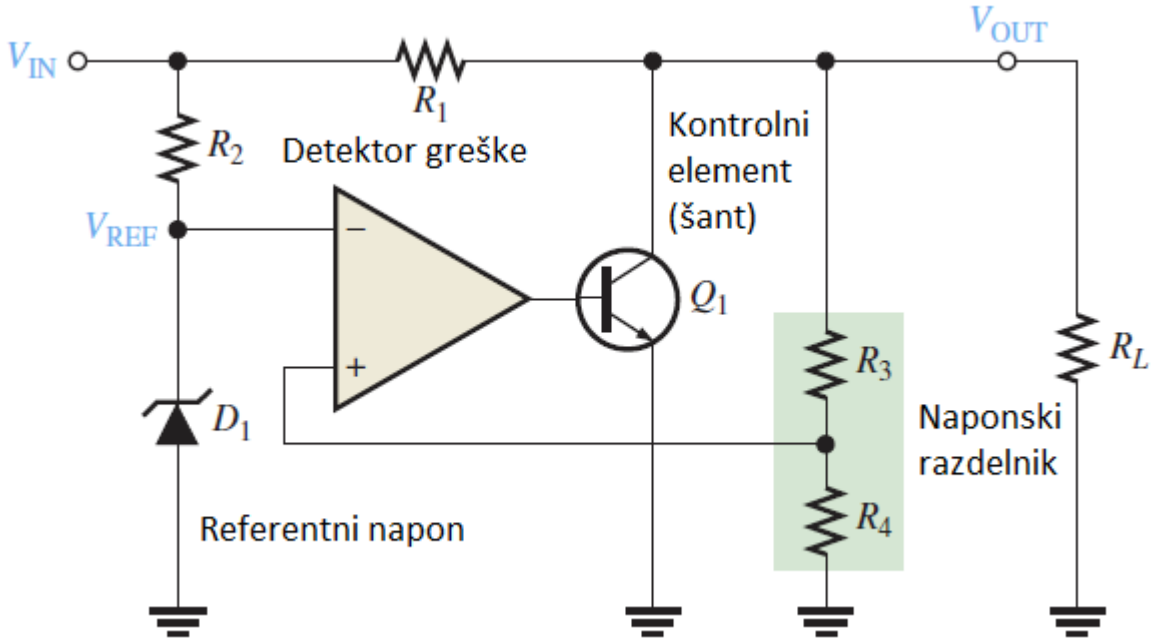
$$I_L = \frac{V_{OUT}}{R_1} + I_G$$

Paralelni stabilizator napona blok dijagram





Paralalni stabilizator napona osnovna električna šema (nepotrebna je zaštita zbog R_1)



$$I_{L(max)} = \frac{V_{IN}}{R_1}$$

Osnove elektronike
III semestar

LINEARNI IZVORI ZA NAPAJANJE