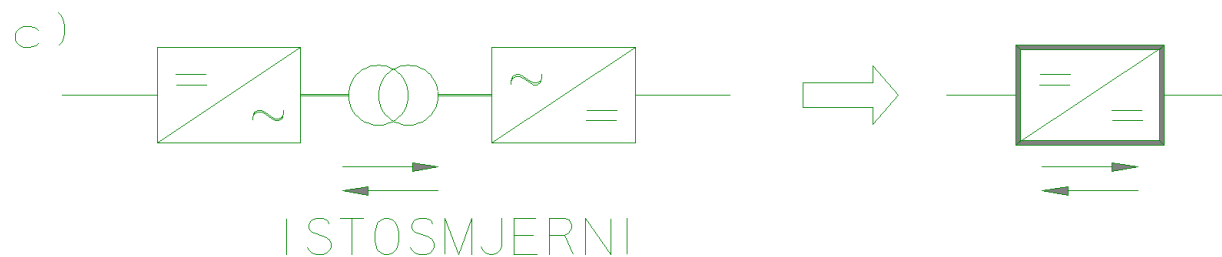
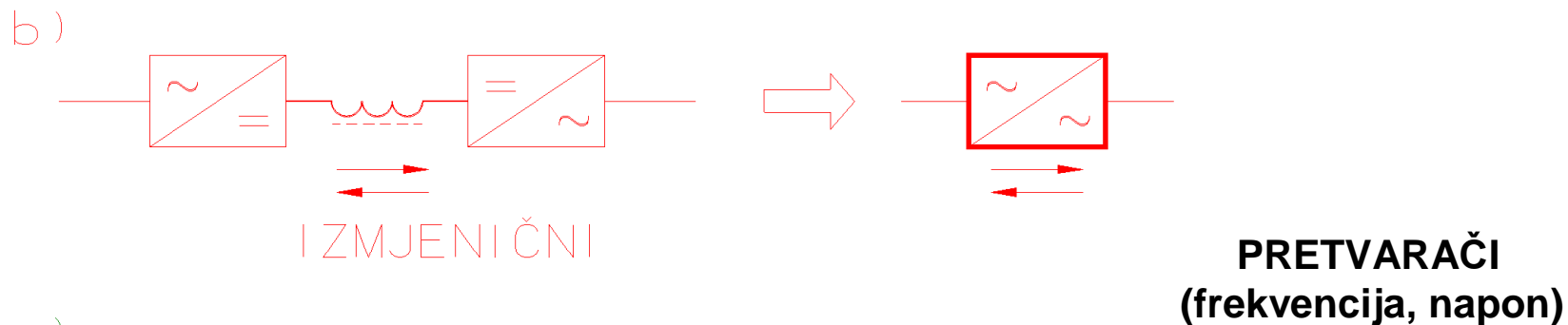
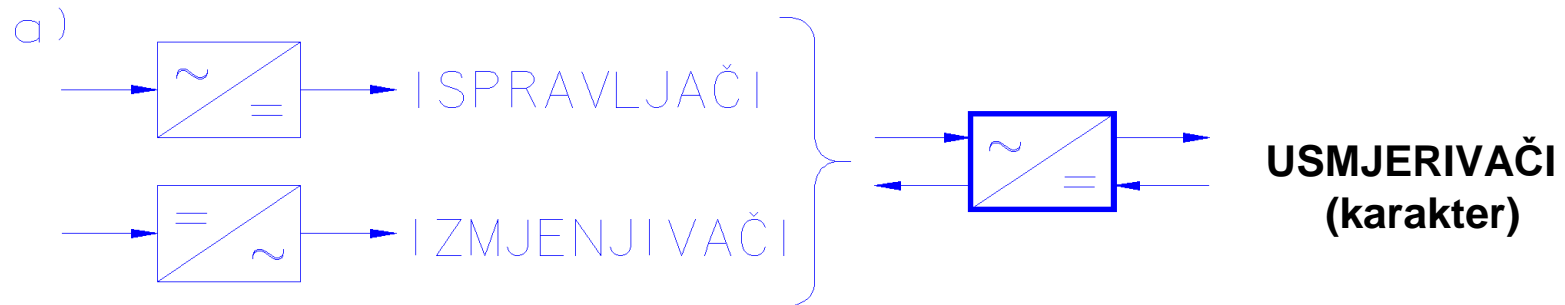


ENERGETSKA ELEKTRONIKA

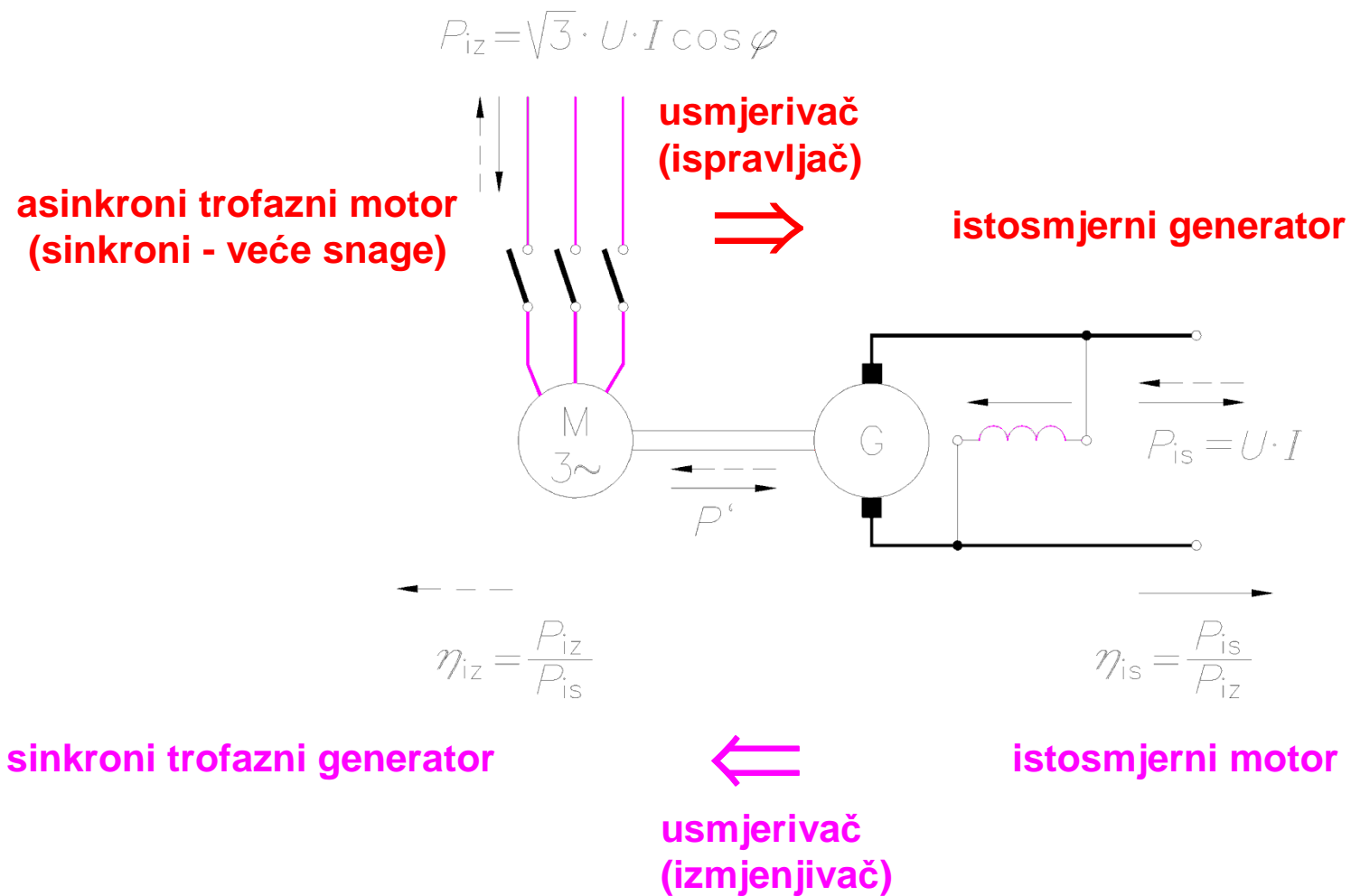
pretvaranje **raspoložive** električne energije u **potrebnu** (karakterom, naponom i frekvencijom)

osnovne funkcije



ROTACIJSKI PRETVARAČI

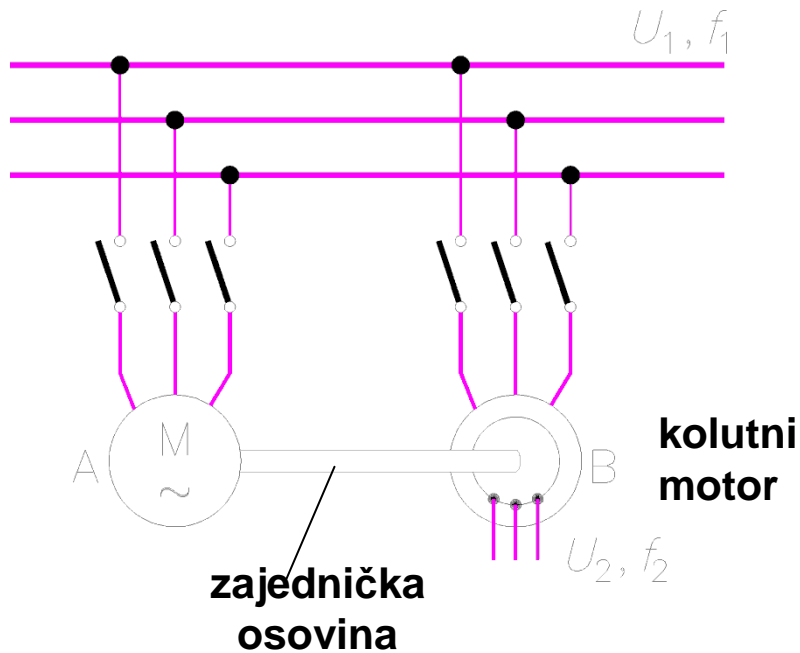
Motorgenerator - dva stroja



Frekvencijski pretvarač

A asinkroni motor - približna f

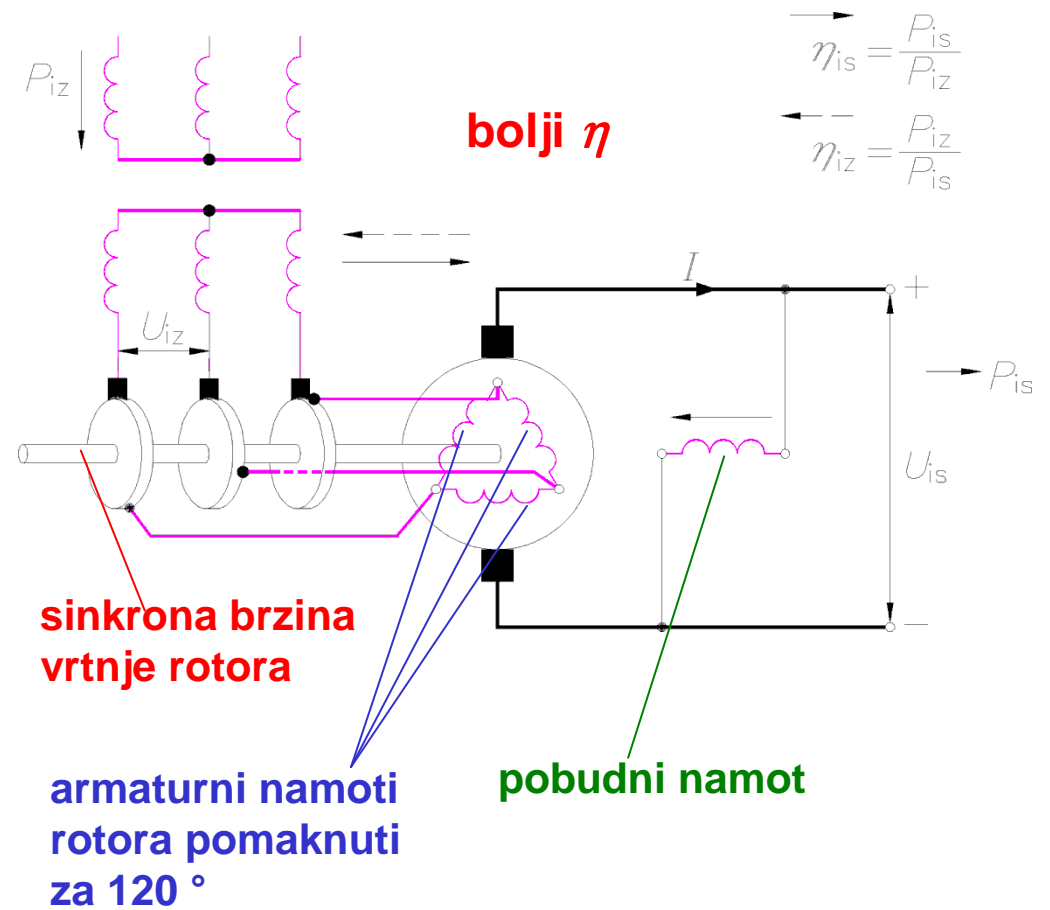
A sinkroni motor - točna f



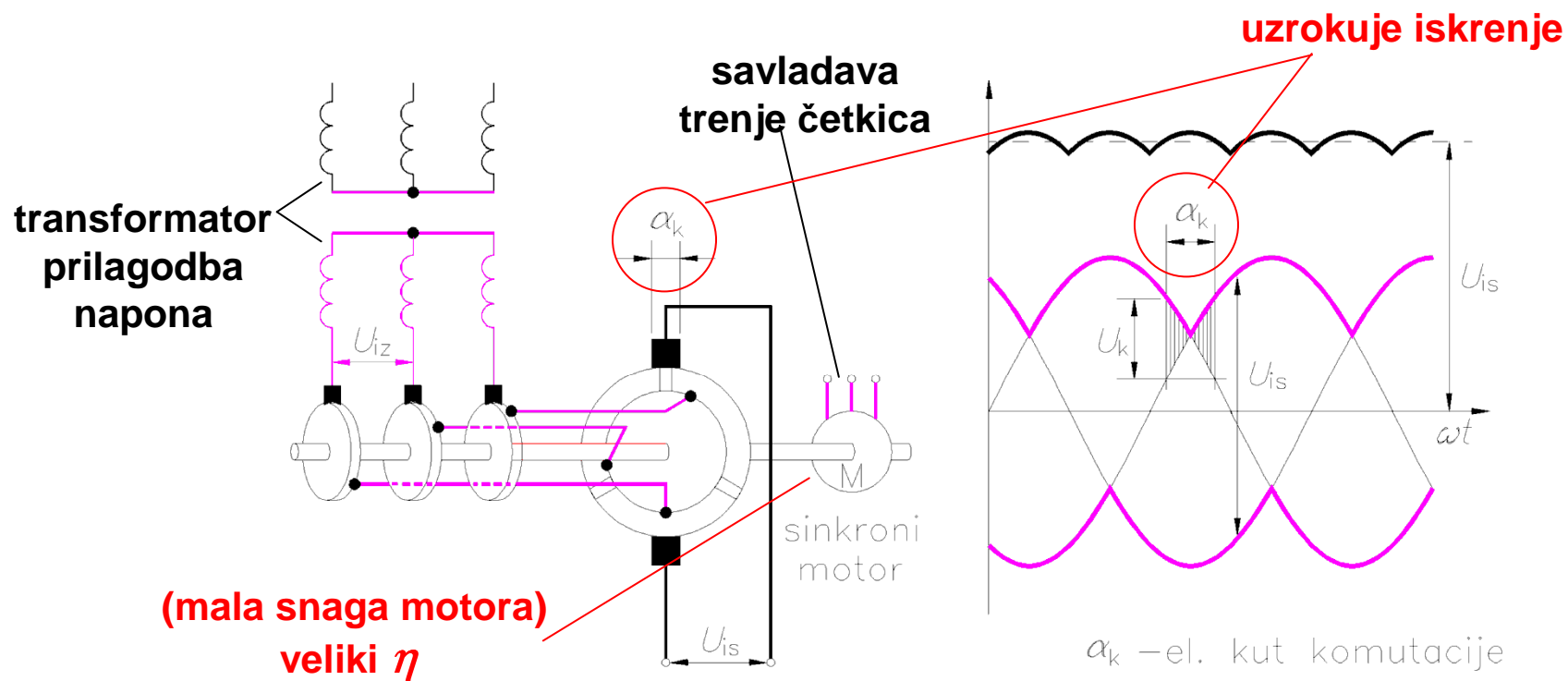
Trofazni jednoarmaturni pretvarač

sinteza sinkronog i istosmjernog stroja

armatura sinkronog i istosmjernog stroja na istom rotoru

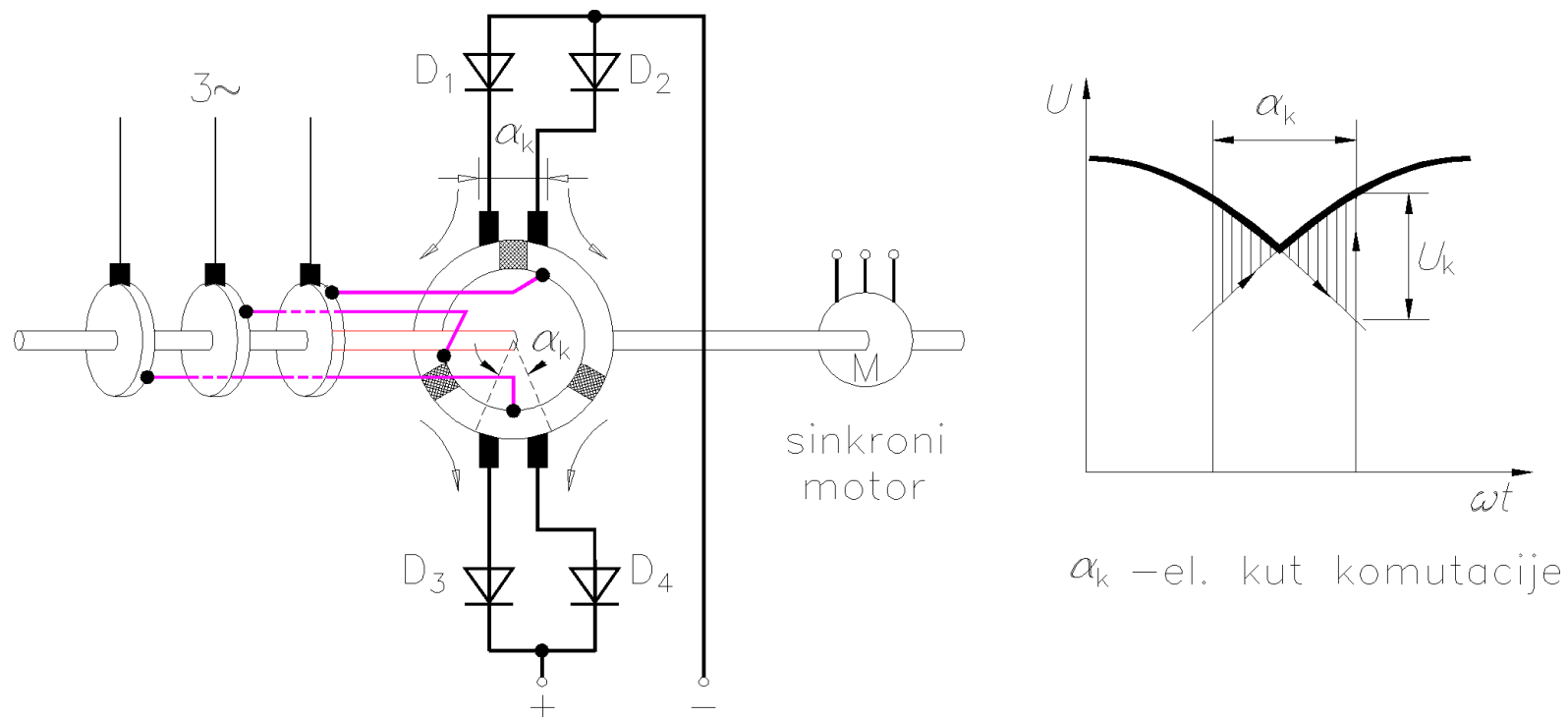


Rotacijski komutacijski pretvarač



\uparrow faza \Rightarrow \downarrow $\alpha_k \Rightarrow$ \downarrow $U_k \Rightarrow$ \downarrow iskrenje \Rightarrow \downarrow valovitost U_{Σ}

Rotacijski ispravljač s usmjerivačkim ventilima

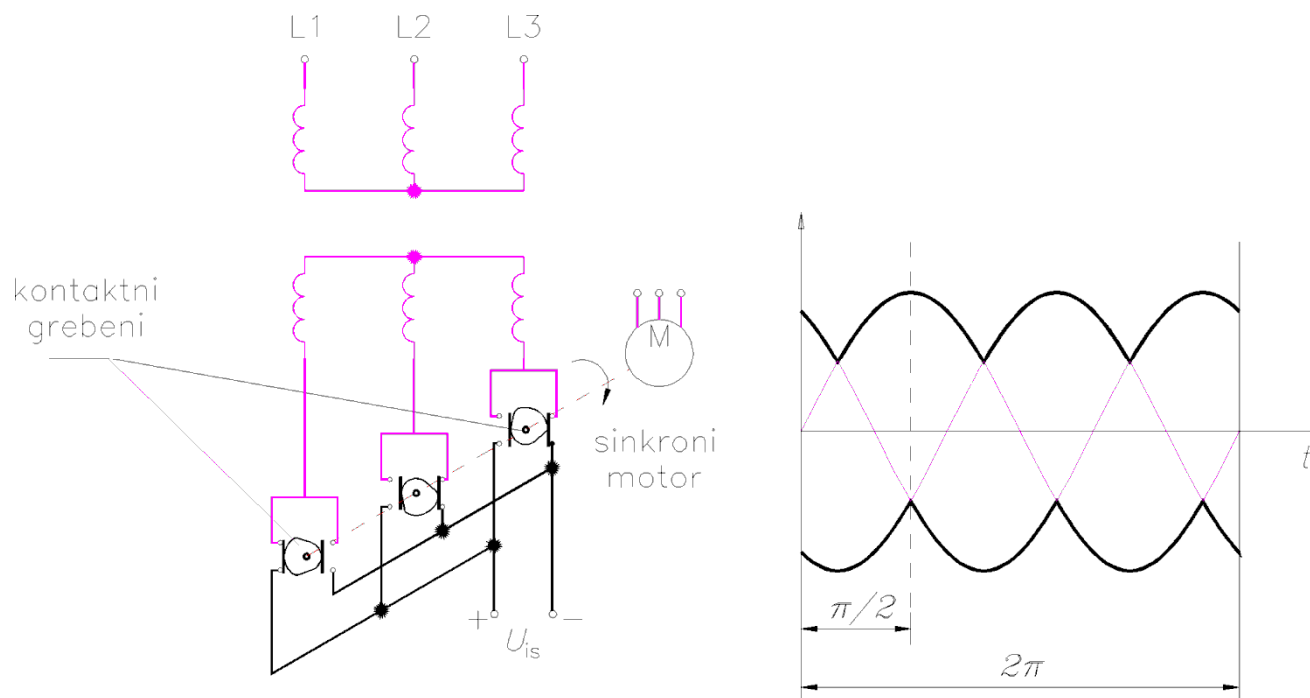


komutacija bez iskrenja

širina četkice uža od širine izolacije među lamelama

razmak između četkica veći od širine izolacije među lamelama

Rotacijski kontakti ispravljač



tehnoški povoljniji (lakše promjeniti kontakte nego kolektor i četkice)

**komutacija malih napona
(otežano gašenje luka – ograničenje kao i kod drugih istosmjernih strojeva)**

USMJERAVANJE STRUJE

usmjerivačko djelovanje - mogućnost ionizacije molekula

- kombinacija metala
- vakuum
- plinom ili parama punjene cijevi
- elektroliti
- poluvodiči

ISPRAVLJAČI

Neregulirani

vrijeme vođenja struje kroz korištenu komponentu **nepromjenjivo**

napon (struju) određuju

- izvor napajanja
- korišteni spoj
- otpor trošila

komponente

diode - vakuumske
- punjene plinom ili parama
poluvodičke

Regulirani

vrijeme vođenja struje kroz korištenu komponentu **promjenjivo**

napon (struju) određuju

- izvor napajanja
- korišteni spoj
- otpor trošila
- vrijeme vođenja

komponente

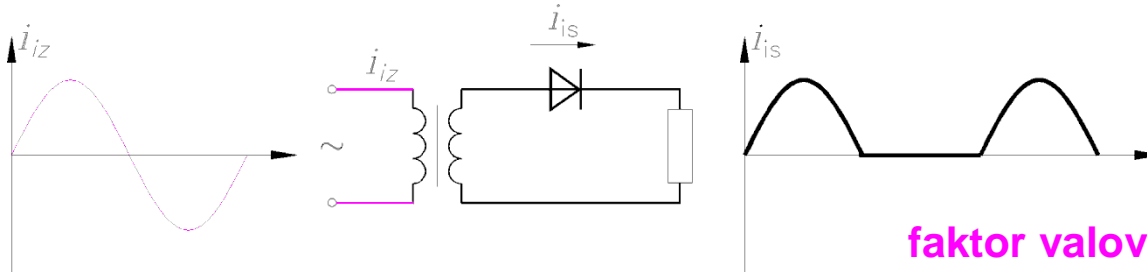
“triode” - vakuumske
- punjene plinom ili parama
- poluvodičke

Neregulirani ispravljači

Poluvalno ispravljanje jednofaznog napona

$$U_{is} = U_{sr} = 0,45 \cdot U_{iz}$$

$$U_e = \frac{U_m}{2} = \frac{\sqrt{2}U_{iz}}{2} = \frac{U_{iz}}{\sqrt{2}}$$



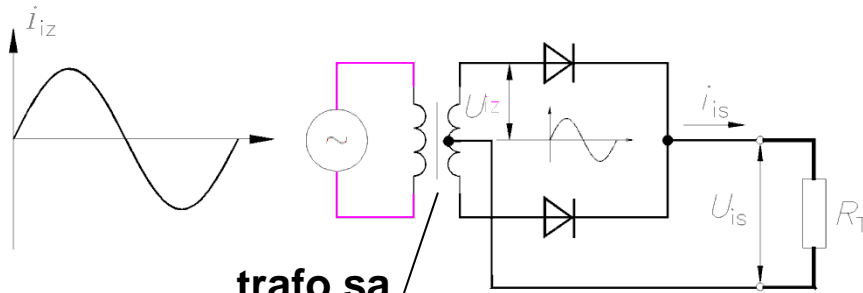
faktor oblika

$$K_0 = \frac{U_e}{U_{is}} = 1,57$$

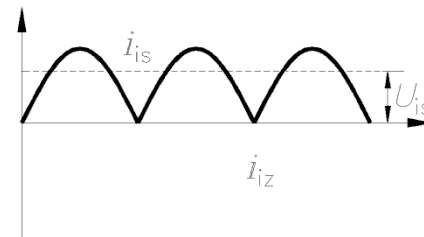
faktor valovitosti

$$K_v = \sqrt{K_0^2 - 1} = 1,21$$

Punovalno ispravljanje jednofaznog napona



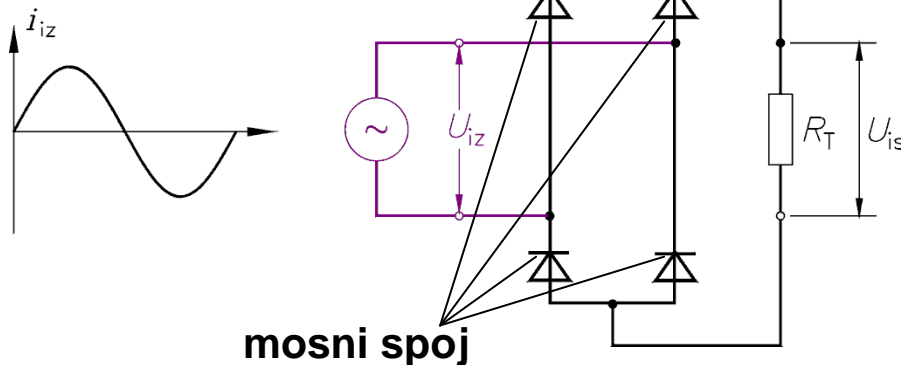
trafo sa srednjim izvodom



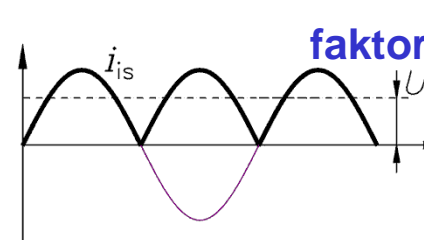
$$U_{is} = U_{sr} = \frac{2}{\pi} \cdot U_m$$

$$= \frac{2\sqrt{2}}{\pi} \cdot U_{iz} = 0,90 \cdot U_{iz}$$

$$U_e = \frac{U_m}{\sqrt{2}} = \frac{\sqrt{2}U_{iz}}{\sqrt{2}} = U_{iz}$$



mosni spoj



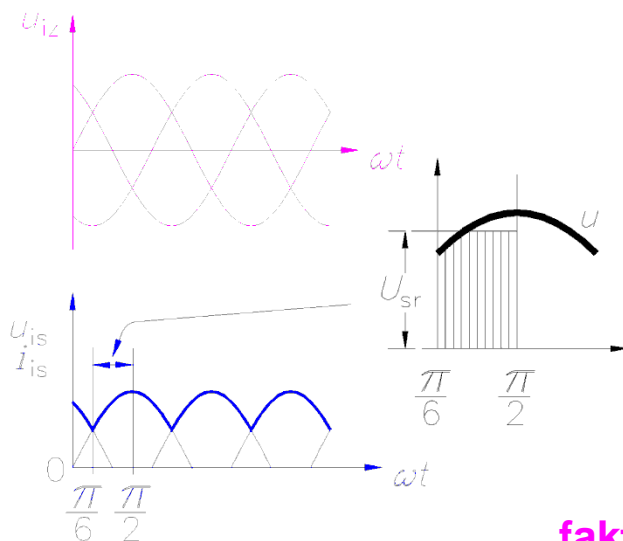
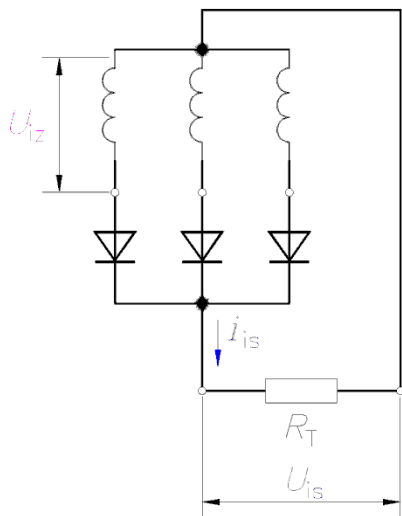
faktor oblika

$$K_0 = \frac{U_e}{U_{is}} = 1,11$$

faktor valovitosti

$$K_v = \sqrt{K_0^2 - 1} = 0,48$$

Poluvalno ispravljanje trofaznog napona



$$U_{is} = U_{sr} = 1,17U_{iz}$$

$$U_e = 0,84U_m = 0,84\sqrt{2}U_{iz}$$

faktor oblika

$$K_0 = \frac{U_e}{U_{is}} = 1,0165$$

faktor valovitosti

$$K_v = \sqrt{K_0^2 - 1} = 0,18$$

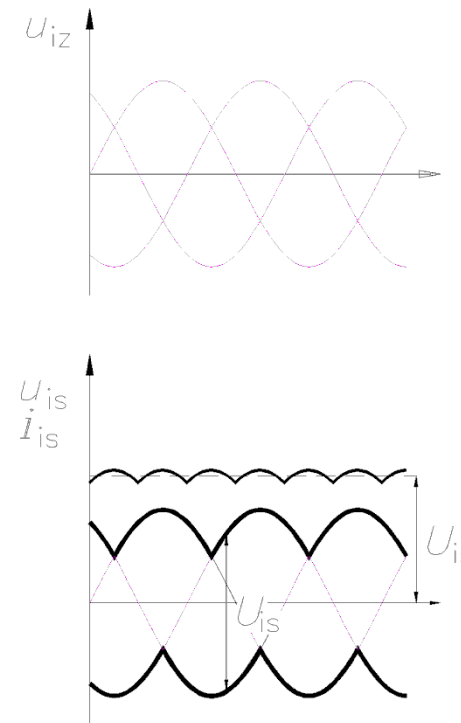
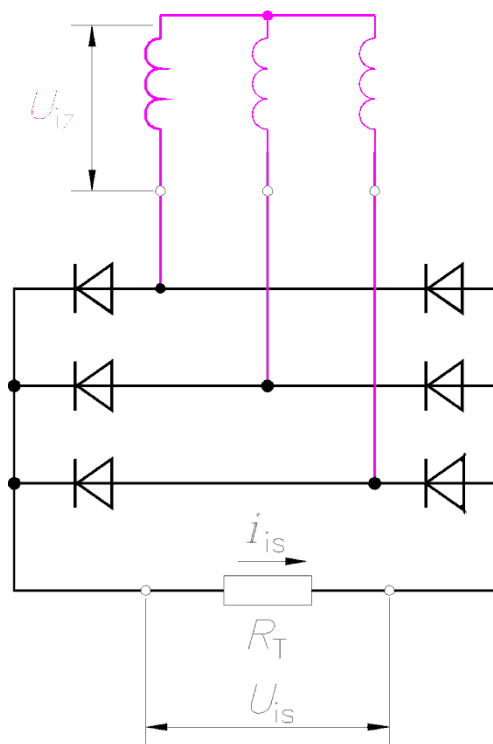
Punovalno ispravljanje trofaznog napona

faktor oblika

$$K_0 = \frac{U_e}{U_{is}} = 0,998 \approx 1$$

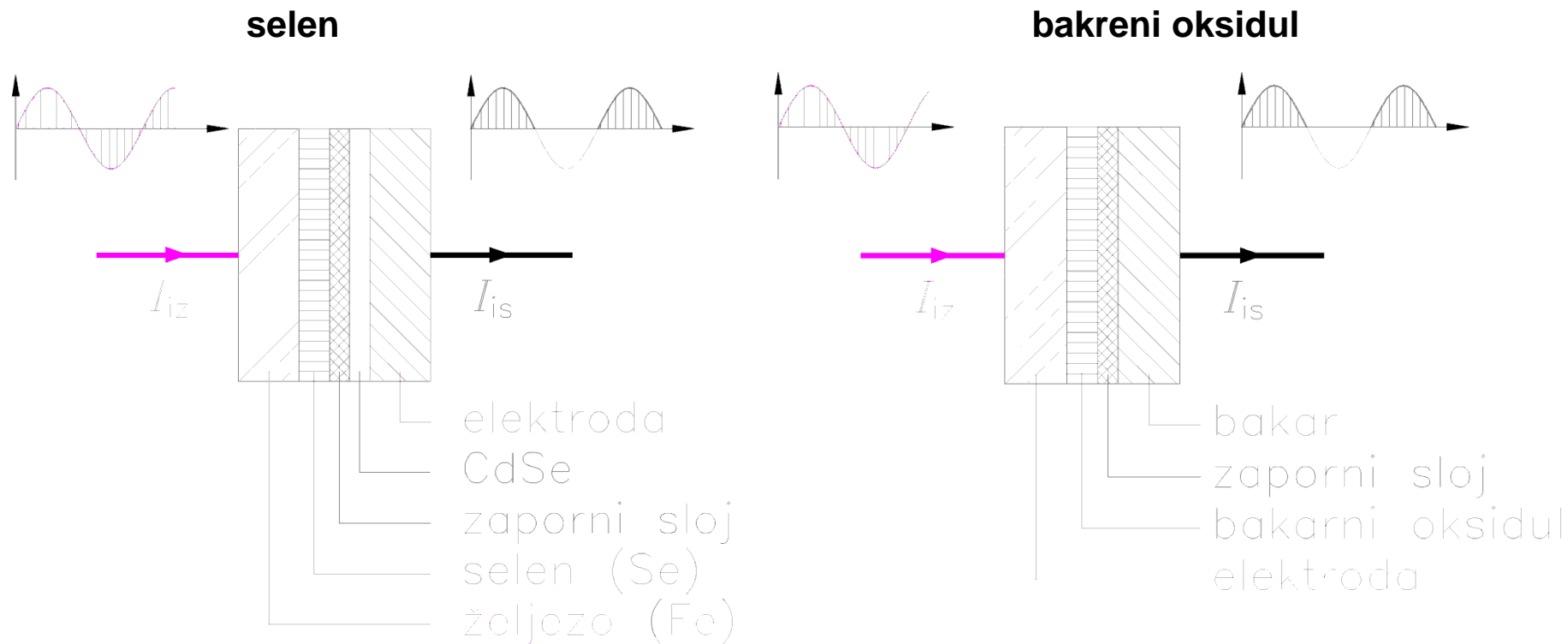
faktor valovitosti

$$K_v = \sqrt{K_0^2 - 1} = 0,042$$



Diode

kombinacija metala



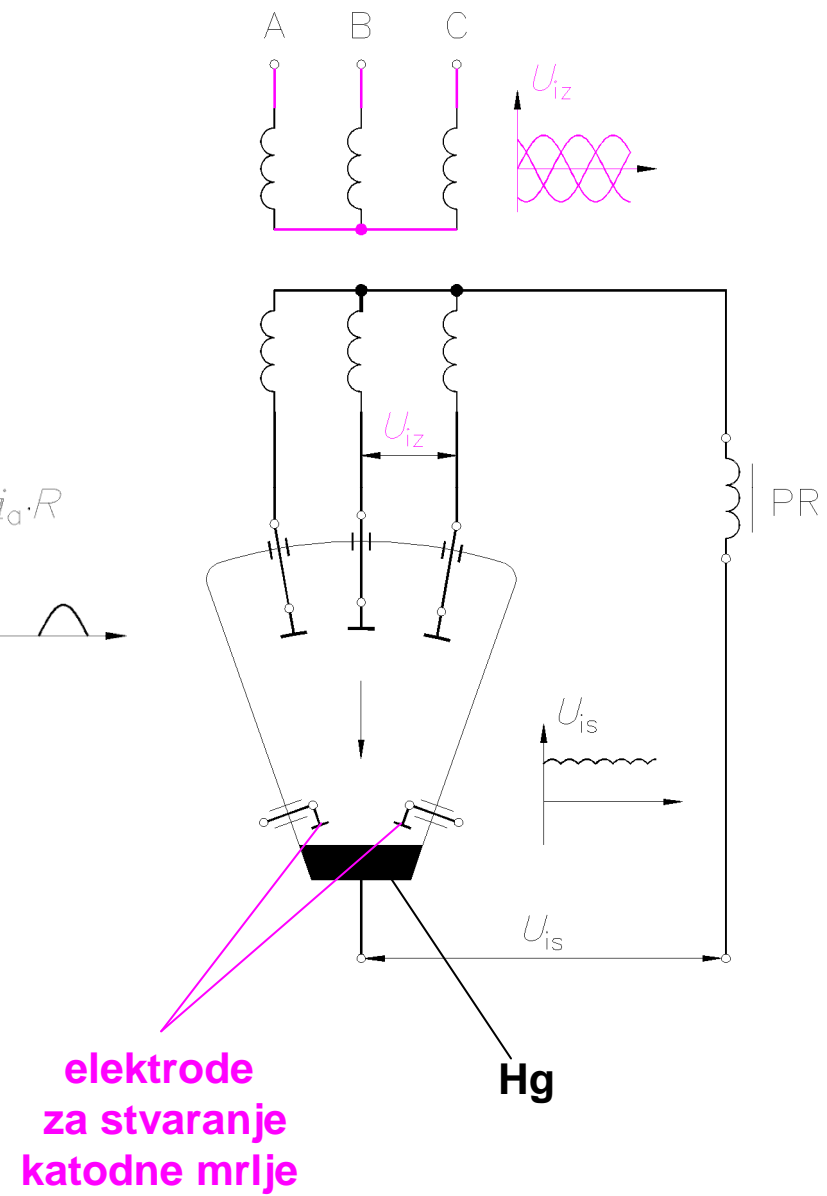
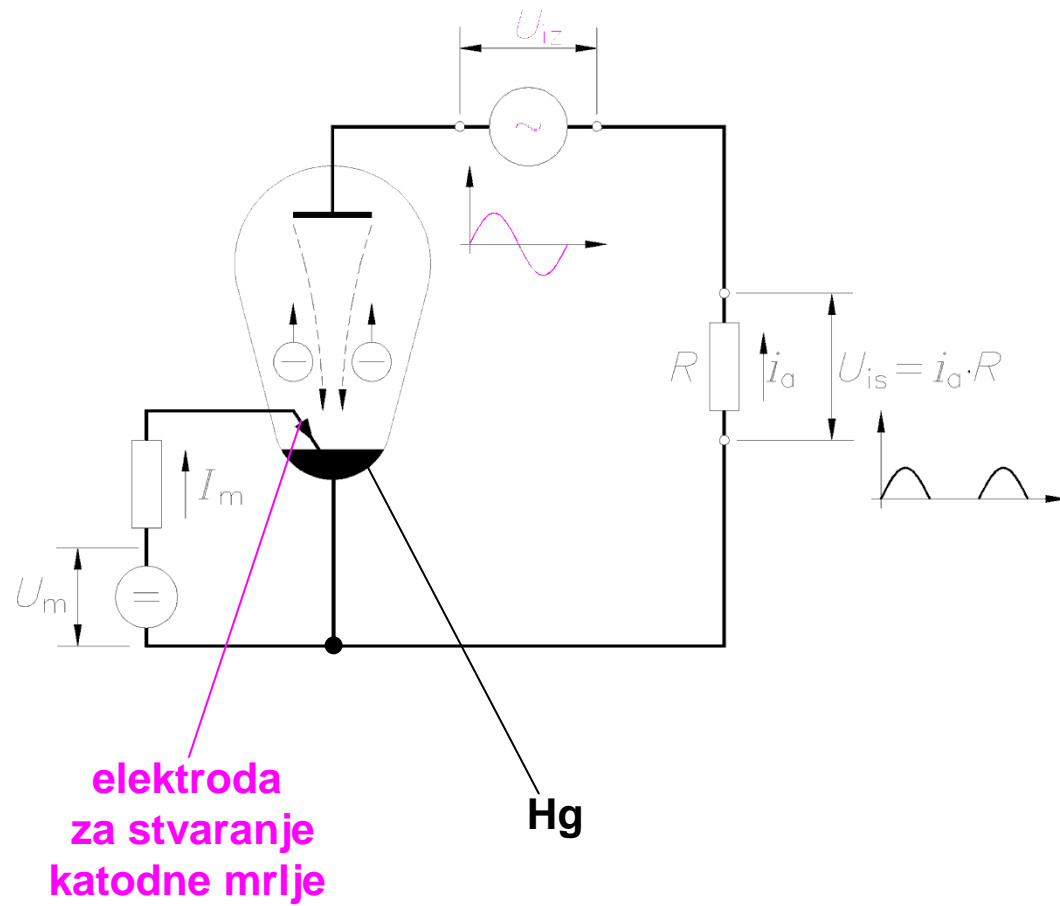
$U_{\text{probojno}} = 35-40V$

U_{probojno} i I manje nego kod Se

I do $50\text{mA}/\text{cm}^2$ uz hladnjake

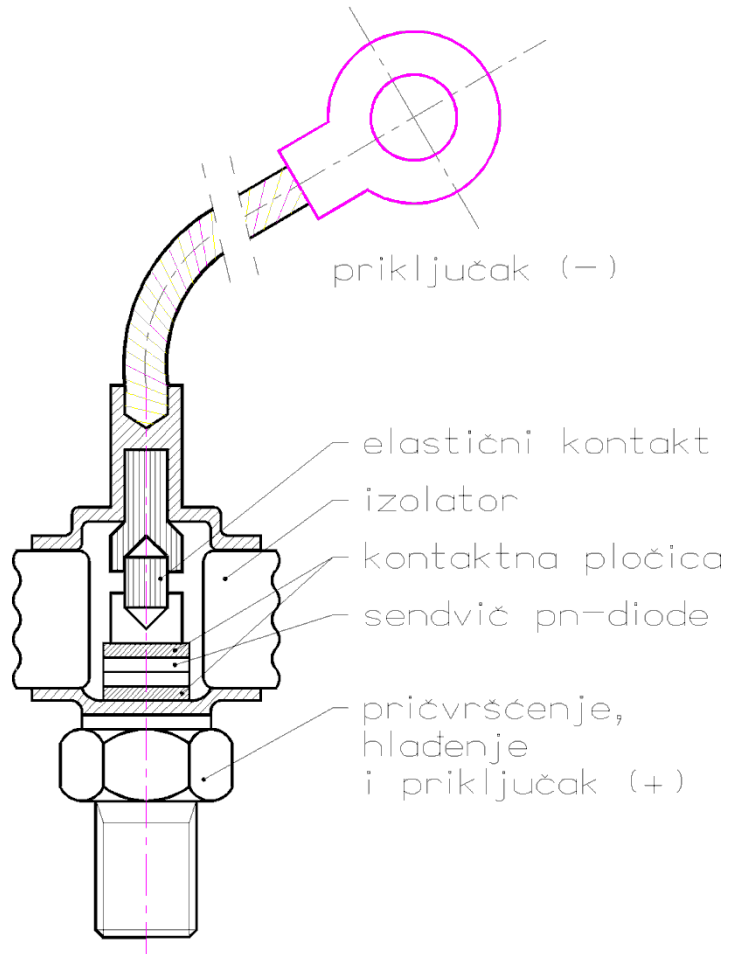
pad napona u propusnom smjeru do 20% - nisu energetski uporabljivi

Živini ispravljači (ignitroni)



Energetska poluvodička dioda

VOĐENJE: mali pad U ; velika gustoća I

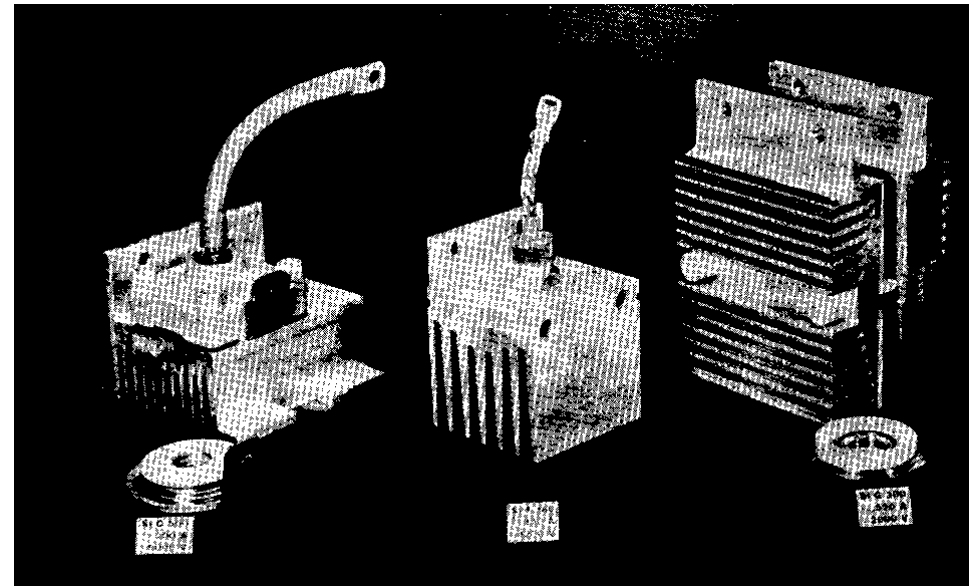


struje $> 10^3\text{A}$

troslojna - ($N^+ N^-$) P^+

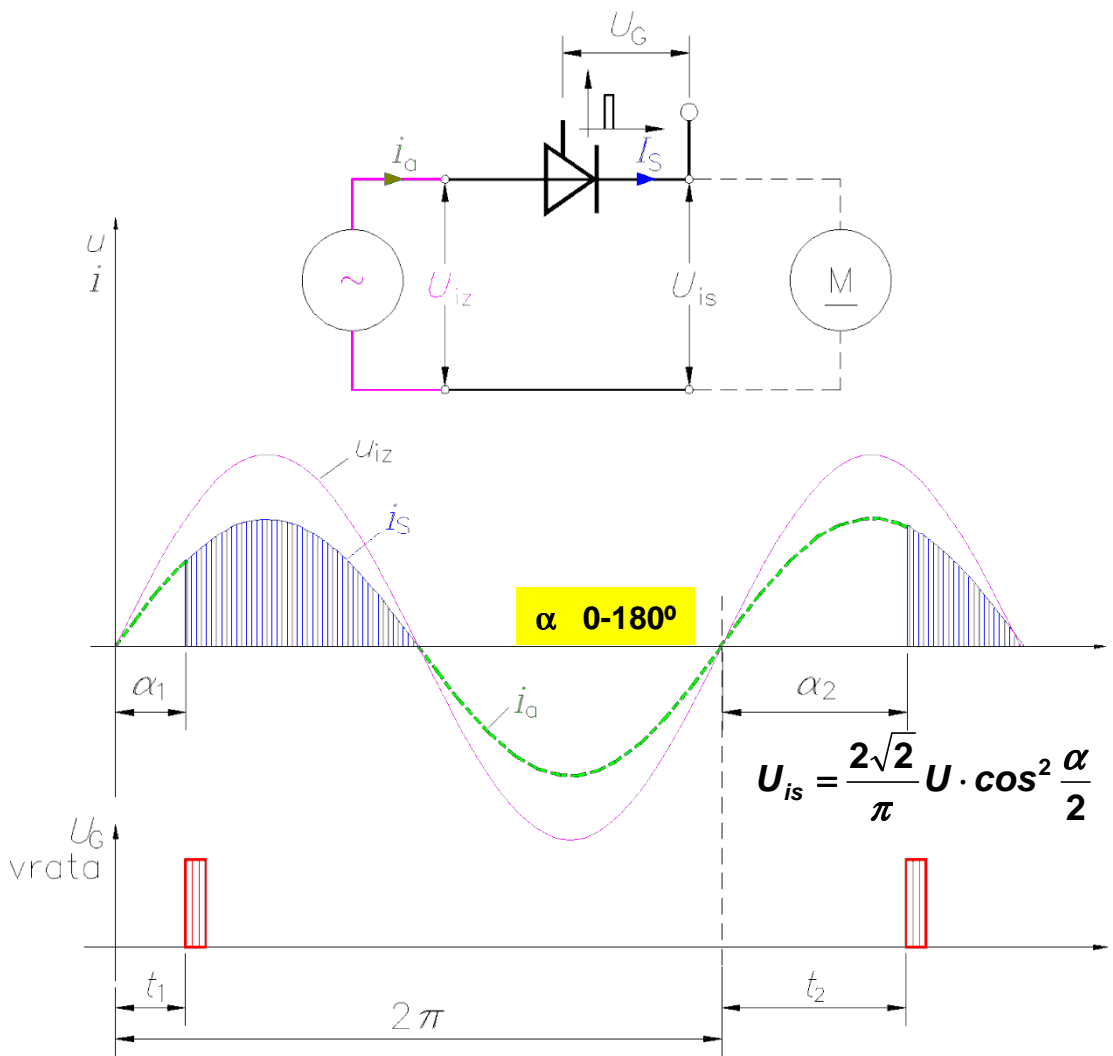
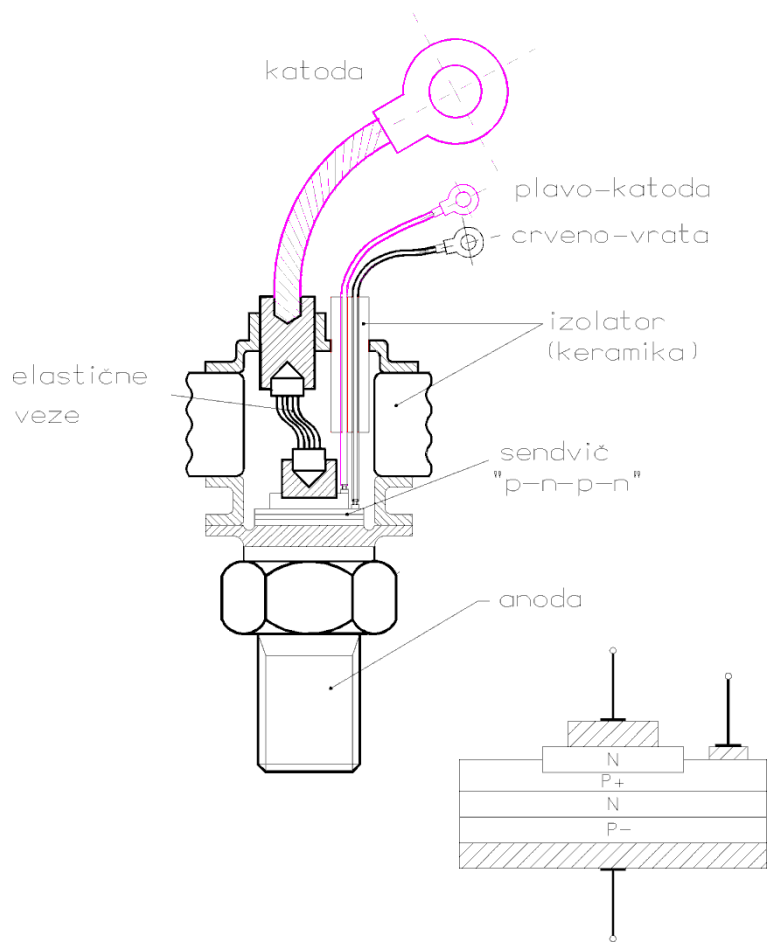
ZAPOR: veliki probojni U ; mala I

- zrakom
hladenje - vodom
- tekućim plinom

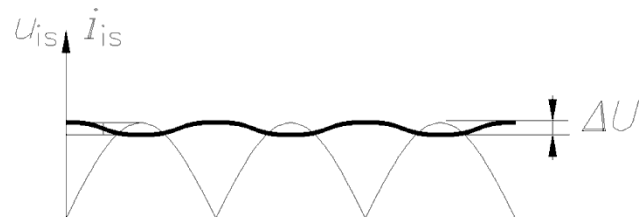
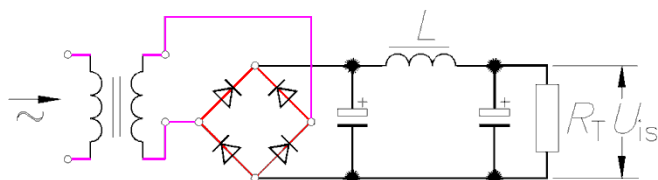
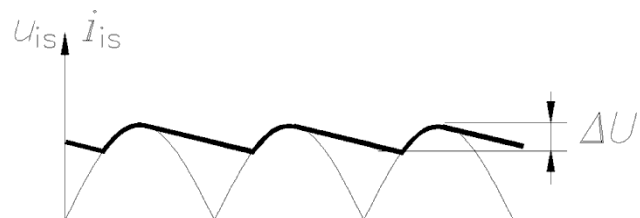
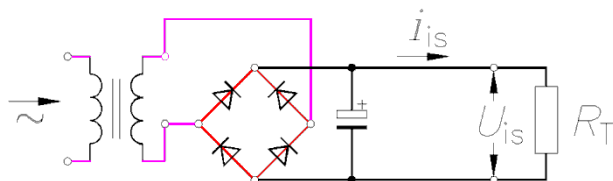
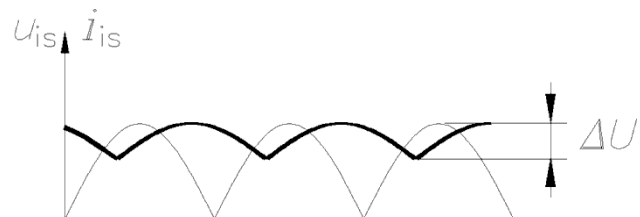
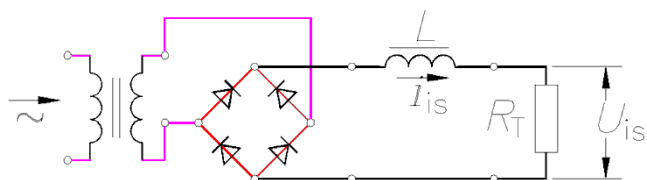
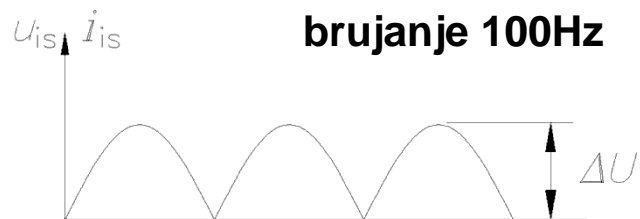
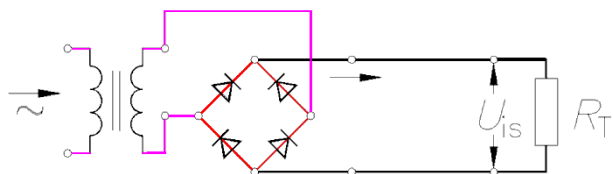


Regulirani ispravljači

Tiristor

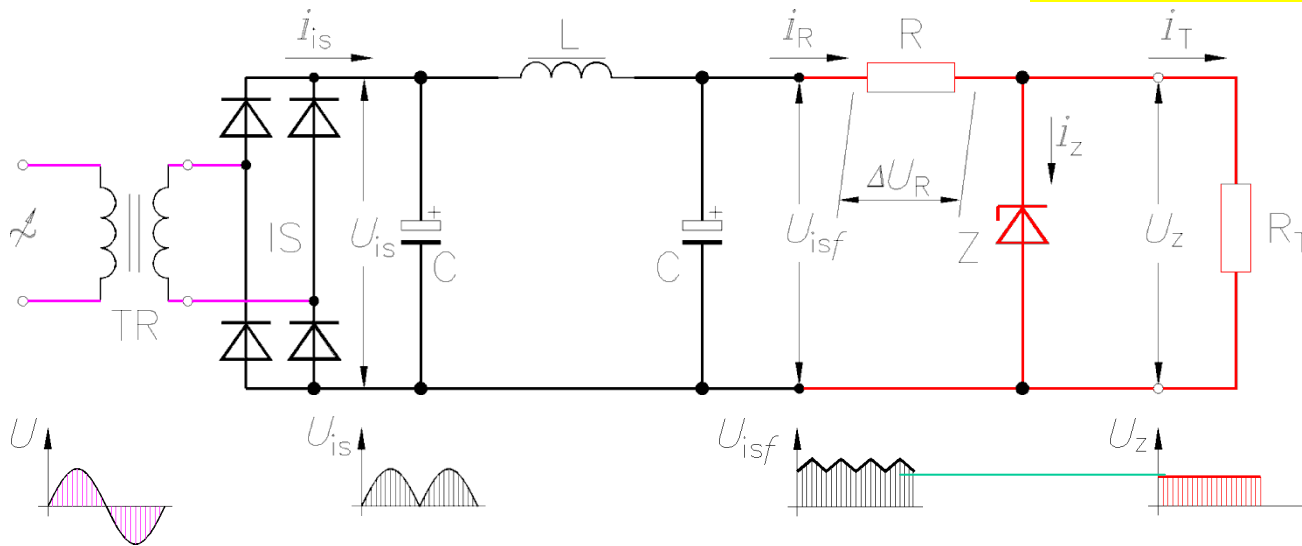


FILTRIRANJE ISPRAVLJENOG NAPONA



STABILIZACIJA NAPONA I STRUJE

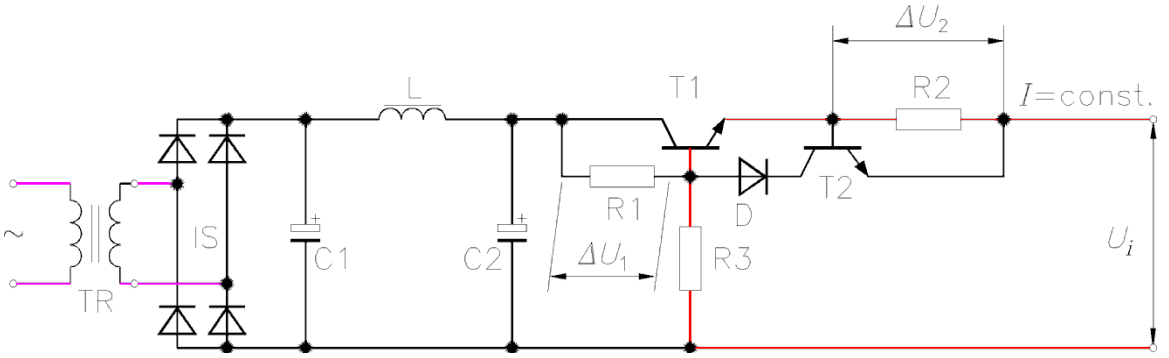
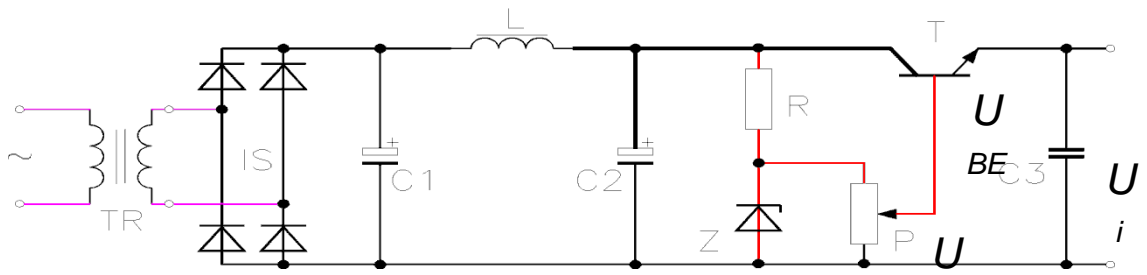
Stabilizacija napona Z diodom



$$U_{isf} = U_Z + \Delta U_R = U_Z + i_R \cdot R$$

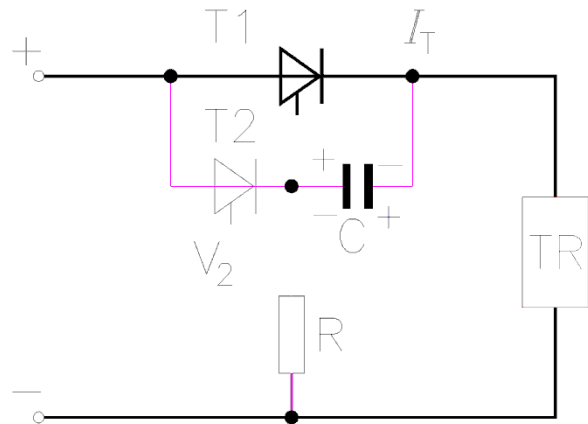
$$i_T \leq i_R - i_{Zmin}$$

Stabilizacija napona tranzistorima

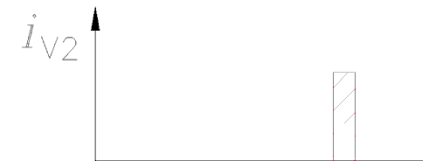
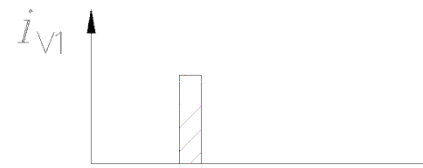
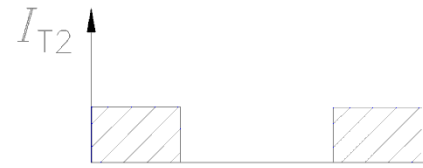
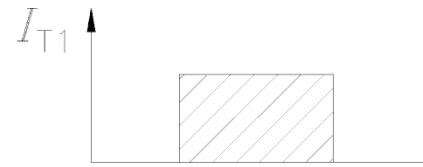


Stabilizacija struje tranzistorima

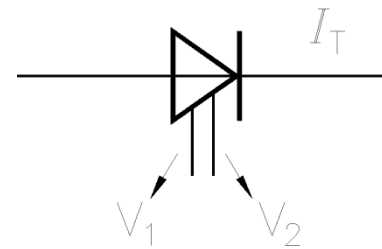
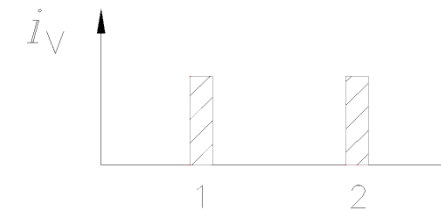
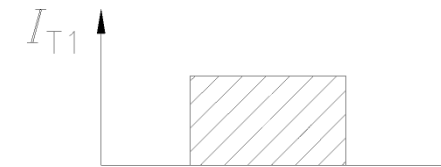
REGULACIJA I UPRAVLJANJE ISTOSMJERNOG IZVORA



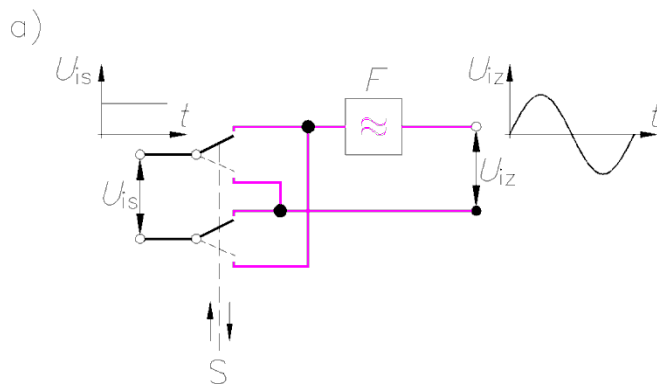
shematizirani prikaz
isklozivih tiristora za
istosmjernu struju



upravljanje tiristorom kod
reguliranih izvora u
istosmjernom strujnom krugu

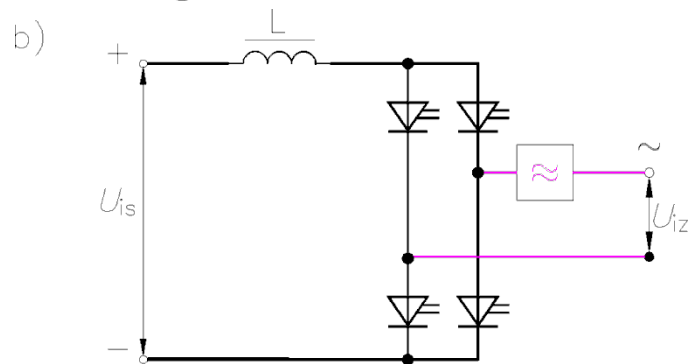


IZMJENJIVAČI ISTOSMJERNOG NAPONA U IZMJENIČNI

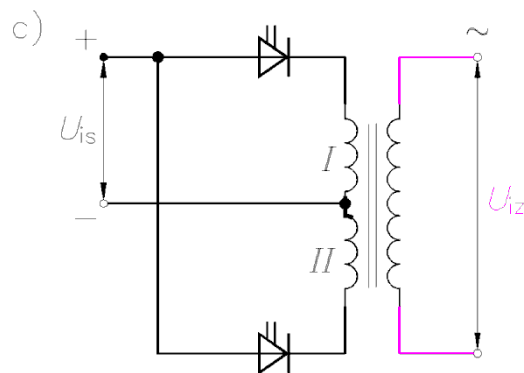


mehanička preklopka i filtriranje

***f* ovisi o brzini preklapanja**



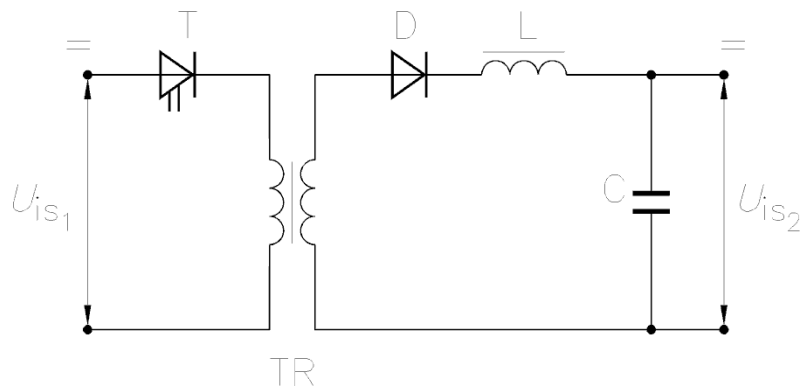
četiri isklopiva tiristora za istosmjernu struju u mosnom spoju i filtriranje



dva isklopiva tiristora za istosmjernu struju i transformator sa srednjim izvodom i filtriranje

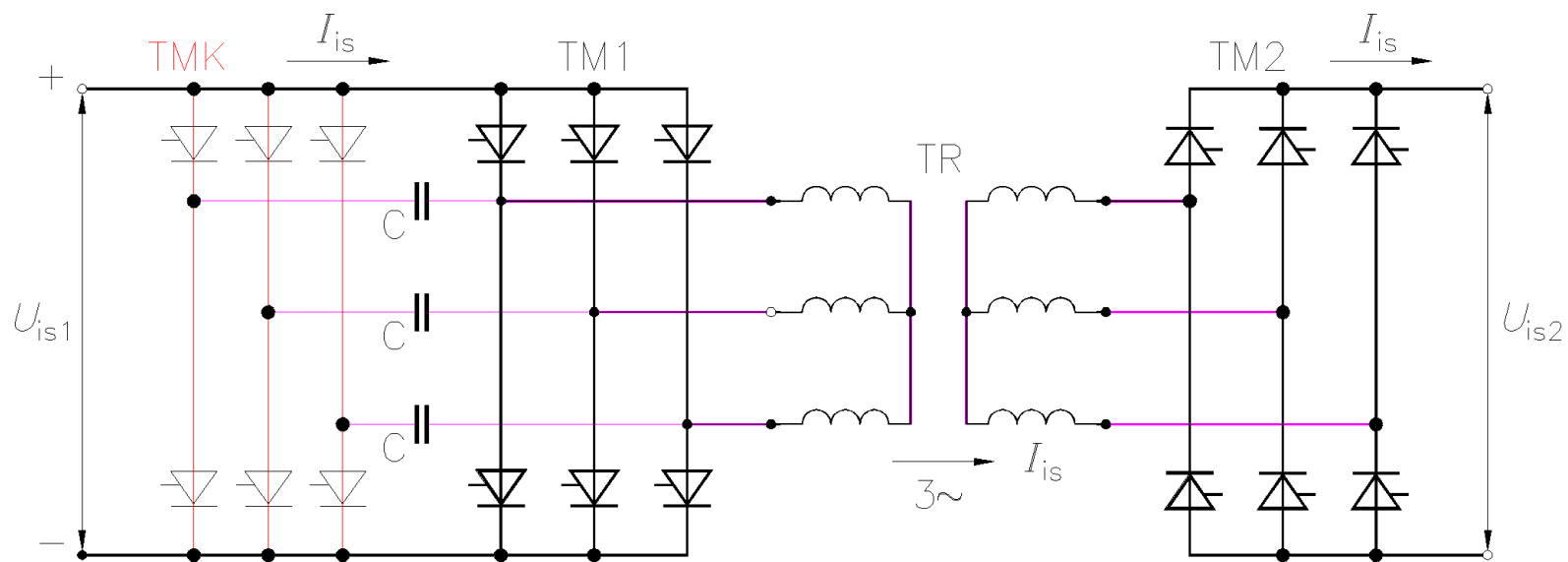
PRETVARANJE STRUJE

Istosmjerni pretvarači (DC-DC pretvarači)

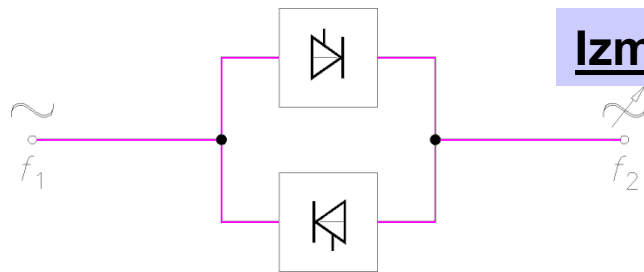


potreban napon veći
od raspoloživog napona izvora
PEX, mjerna i regulacijska tehnika

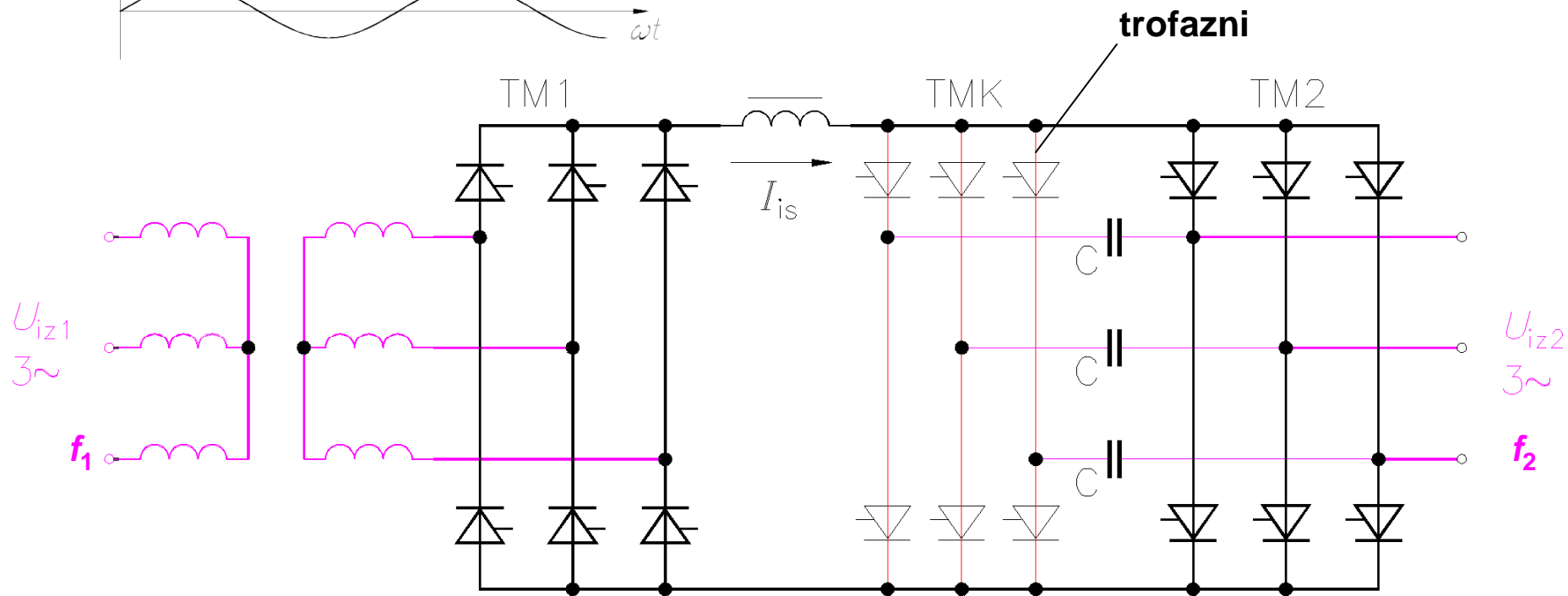
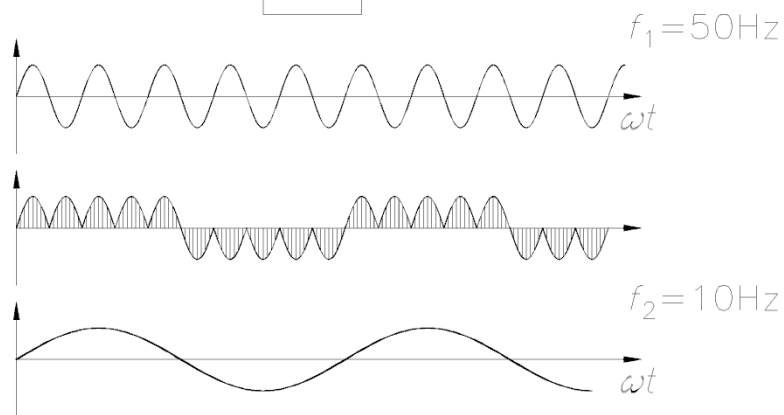
energetski istosmjerni pretvarači (trofazni)

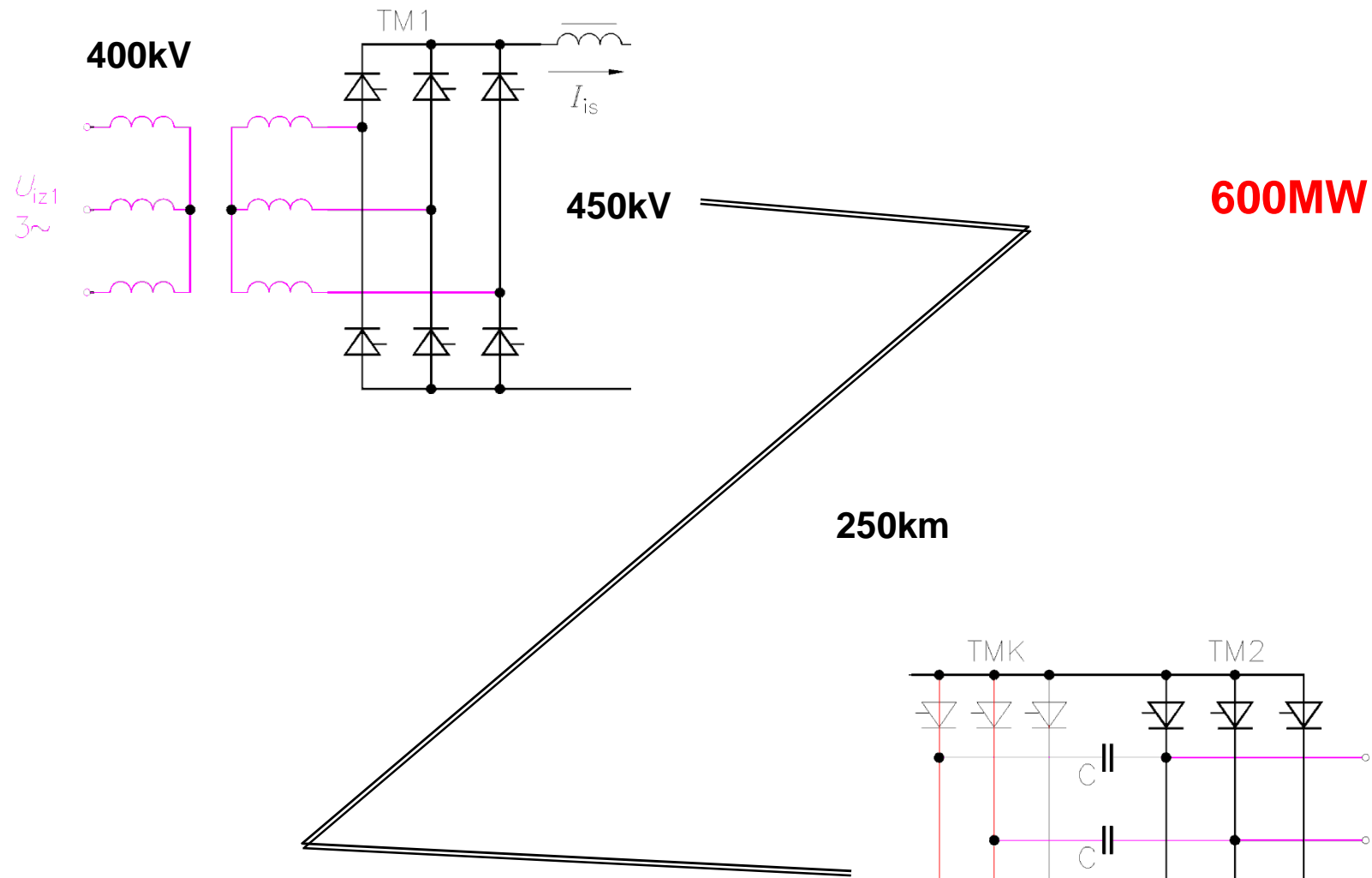


Izmjenični pretvarači



Jednofazni (djelitelji frekvencije)



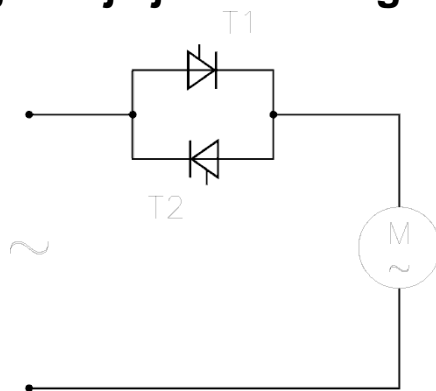


ukupno instalirano > 3000MW

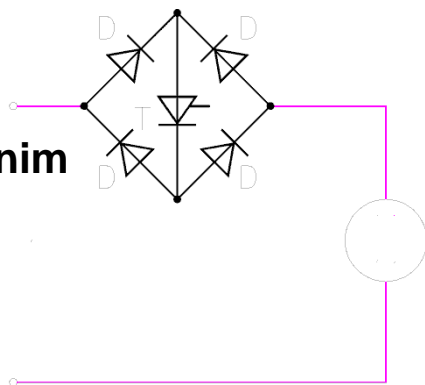
REGULACIJA I UPRAVLJANJE IZMJENIČNOG NAPONA

upravljanje i regulacija jednofaznog napona

s dva tiristora



s diodnom mosnim spojem i jednim tiristorom



s tirakom

