

SCR

Silicon Controlled Rectifiers

ELEKTRONIKA KONTROL

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BT151-500R

SCR, 12 A, 15mA, 500 V, SOT78

Rev. 05 — 2 March 2009

Product data sheet

1. Product profile

1.1 General description

Planar passivated SCR (Silicon Controlled Rectifier) in a SOT78 plastic package.

1.2 Features and benefits

- High reliability
- High thermal cycling performance
- High surge current capability

1.3 Applications

- Ignition circuits
- Protection Circuits
- Motor control
- Static switching

1.4 Quick reference data

Table 1. Quick reference

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DRM}	repetitive peak off-state voltage		-	-	500	V
$I_{T(AV)}$	average on-state current	half sine wave; $T_{mb} \leq 100^\circ\text{C}$; see Figure 3	-	-	7.5	A
$I_{T(RMS)}$	RMS on-state current	half sine wave; $T_{mb} \leq 100^\circ\text{C}$; see Figure 1 ; see Figure 2	-	-	12	A
Static characteristics						
I_{GT}	gate trigger current	$V_D = 12\text{ V}$; $T_J = 25^\circ\text{C}$; $I_T = 100\text{ mA}$; see Figure 8	-	2	15	mA

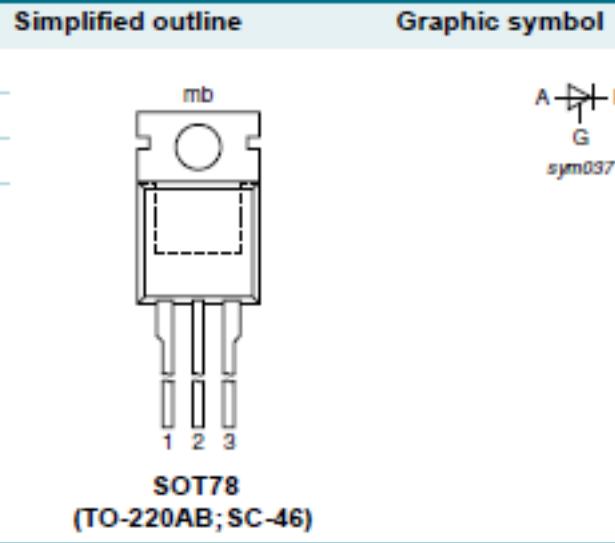


Table 2. Pinning information

Pin	Symbol	Description
1	K	cathode
2	A	anode
3	G	gate
mb	mb	anode

DATASHEET

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DRM}	repetitive peak off-state voltage		-	500	V
V_{RRM}	repetitive peak reverse voltage		-	500	V
$I_{T(AV)}$	average on-state current	half sine wave; $T_{mb} \leq 109^\circ\text{C}$; see Figure 3	-	7.5	A
$I_{T(RMS)}$	RMS on-state current	half sine wave; $T_{mb} \leq 109^\circ\text{C}$; see Figure 1 ; see Figure 2	-	12	A
dI_T/dt	rate of rise of on-state current	$I_T = 20\text{ A}$; $I_G = 50\text{ mA}$; $dI_G/dt = 50\text{ mA}/\mu\text{s}$	-	50	$\text{A}/\mu\text{s}$
I_{GM}	peak gate current		-	2	A
P_{GM}	peak gate power		-	5	W
T_{stg}	storage temperature		-40	150	$^\circ\text{C}$
T_j	junction temperature		-	125	$^\circ\text{C}$
I_{TSM}	non-repetitive peak on-state current	half sine wave; $t_p = 8.3\text{ ms}$; $T_{j(init)} = 25^\circ\text{C}$	-	132	A
		half sine wave; $t_p = 10\text{ ms}$; $T_{j(init)} = 25^\circ\text{C}$; see Figure 4 ; see Figure 5	-	120	A
I^2t	I^2t for fusing	$t_p = 10\text{ ms}$; sine-wave pulse	-	72	A^2s
$P_{G(AV)}$	average gate power	over any 20 ms period	-	0.5	W
V_{RGM}	peak reverse gate voltage		-	5	V

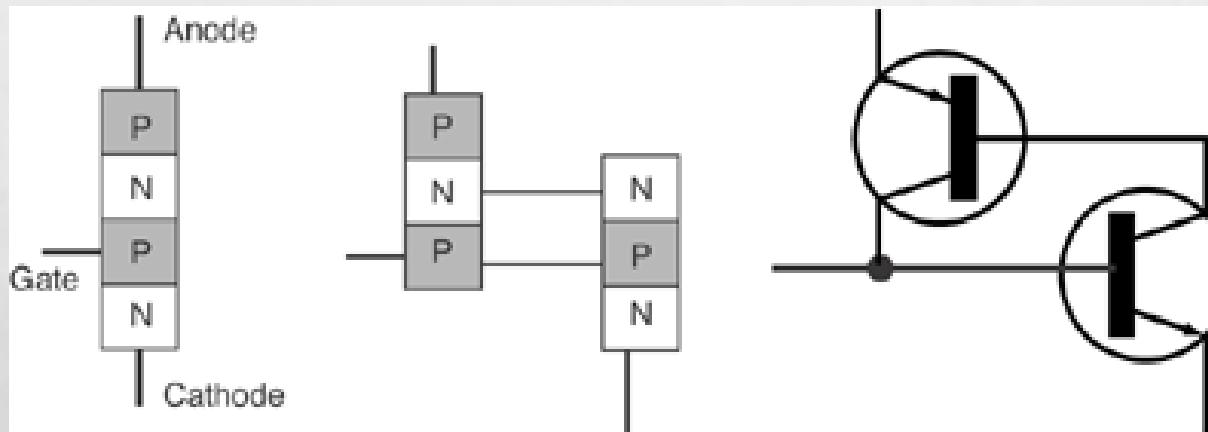
SILICON CONTROLLED RECTIFIER

- SCR DAPAT DIPANDANG SEBAGAI PENYEARAH KONVENTSIONAL YANG DIKENDALIKAN OLEH SINYAL GATE.
- SCR MEMILIKI 4-LAYER DAN 3-TERMINAL
- KETIKA TEGANGAN GATEKE KATODA MELIBIHI THRESHOLD TERTENTU, SCR AKAN 'ON' DAN MENGHANTARKAN ARUS.

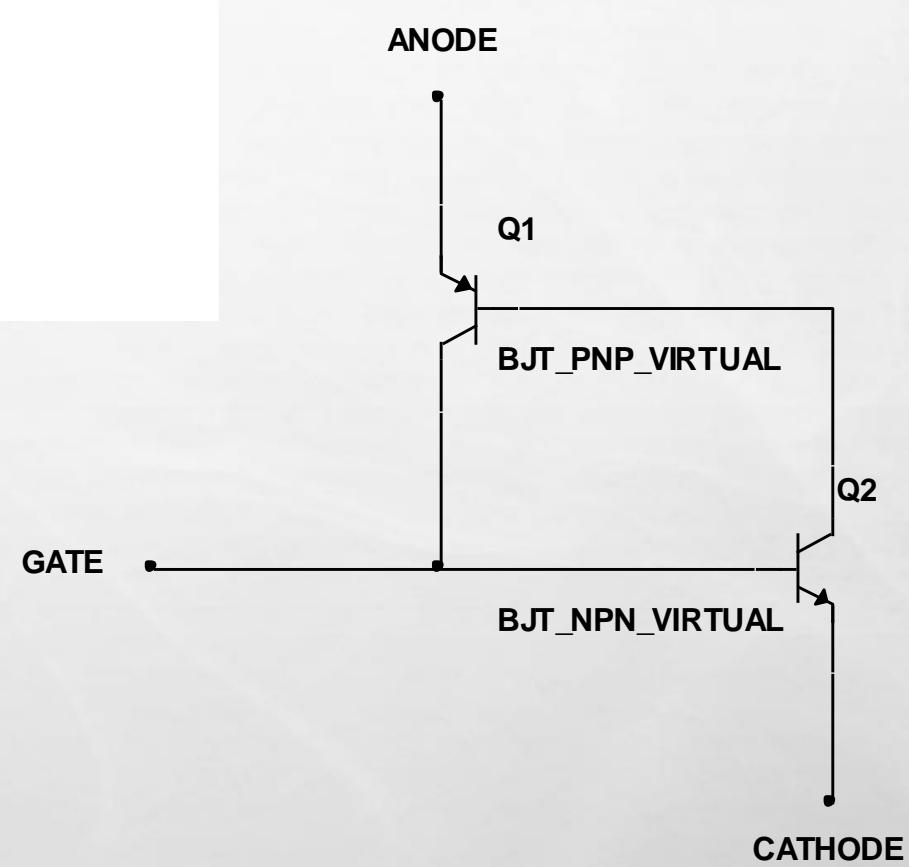
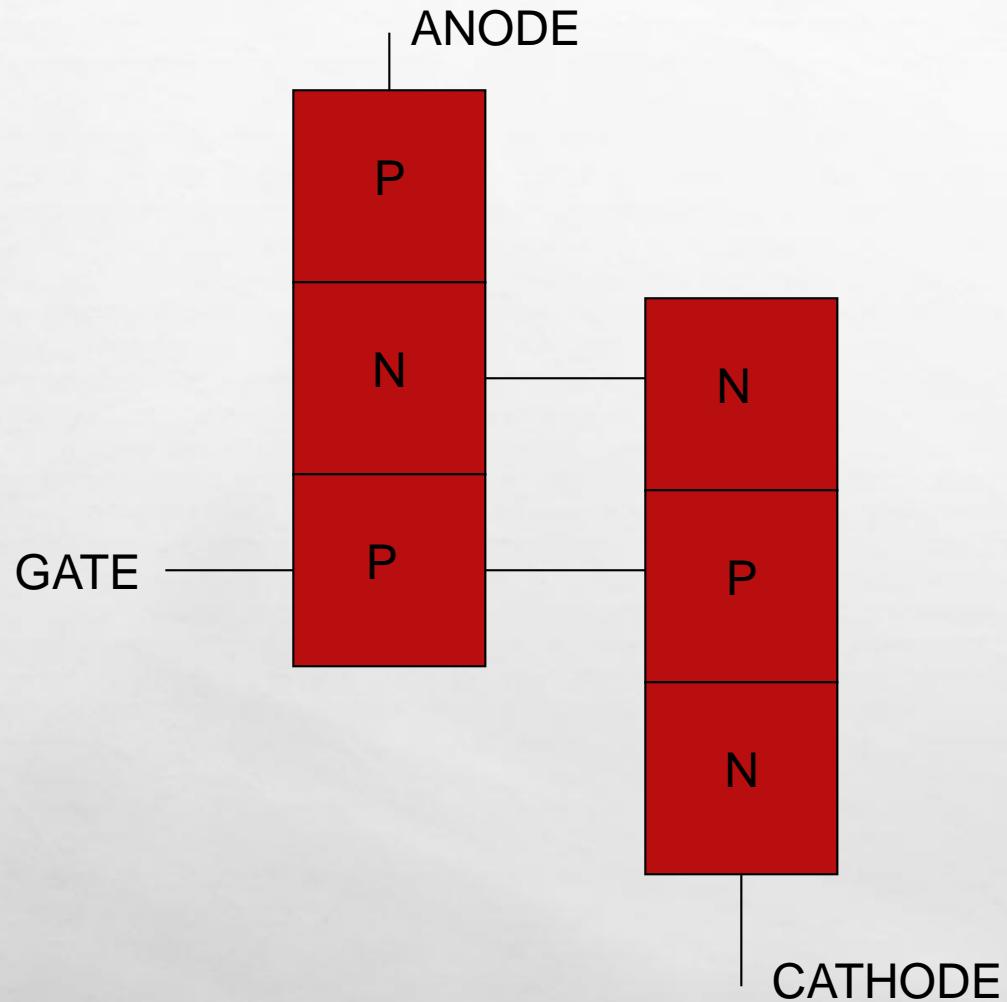


SILICON CONTROLLED RECTIFIER

- OPERASI SCR DAPAT DIPAHAMI DALAM BENTUK PASANGAN BERTINGKAT BJT(**BIPOLAR JUNCTION TRANSISTOR**)
- SCR MEMILIKI TIGA STATE:
 - REVERSE BLOCKING MODE, FORWARD BLOCKING MODE, DAN FORWARD CONDUCTING MODE



EQUIVALENT CIRCUIT

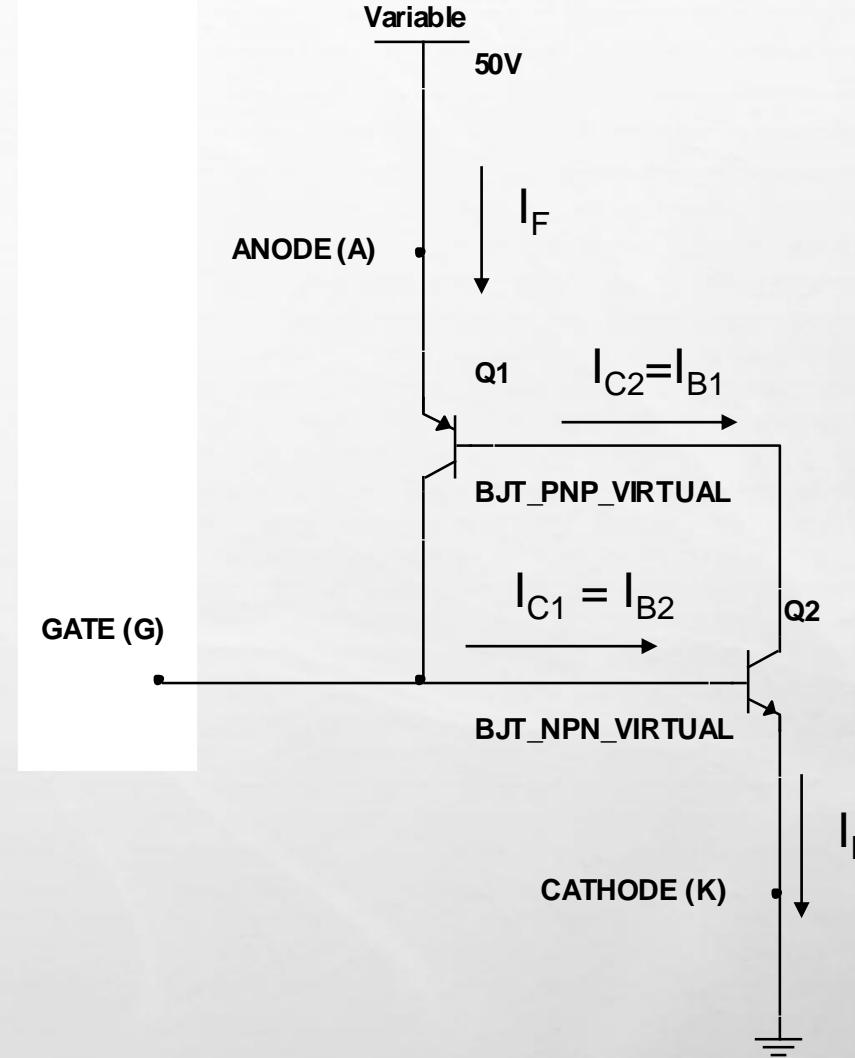


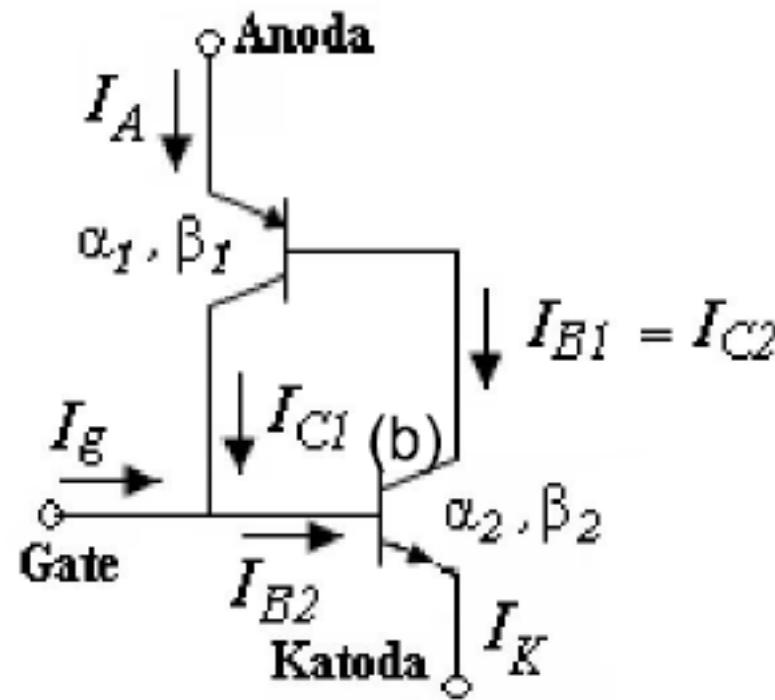
APPLY BIASING

Jika terminal Gate OPEN, kedua transistors OFF.

Jika tegangan meningkat, akan terjadi “breakdown” yang menyebabkan kedua transistor saturasi. sehingga $I_F > 0$ dan $V_{AK} = 0$.

$$V_{\text{Breakdown}} = V_{BR(F)}$$





I_B : Arus basis

I_C : Arus collector

I_A : Arus anoda

I_K : Arus katoda

I_g : Arus gate

$$I_{B1} = (1-\alpha_1) I_A - I_{CBO1} \dots 1)$$

$$I_{C2} = \alpha_2 I_K + I_{CBO2} \dots 2)$$

$$I_{B1} = I_{C2}$$

$$(1-\alpha_1) I_A - I_{CBO1} = \alpha_2 I_K + I_{CBO2} \dots 3)$$

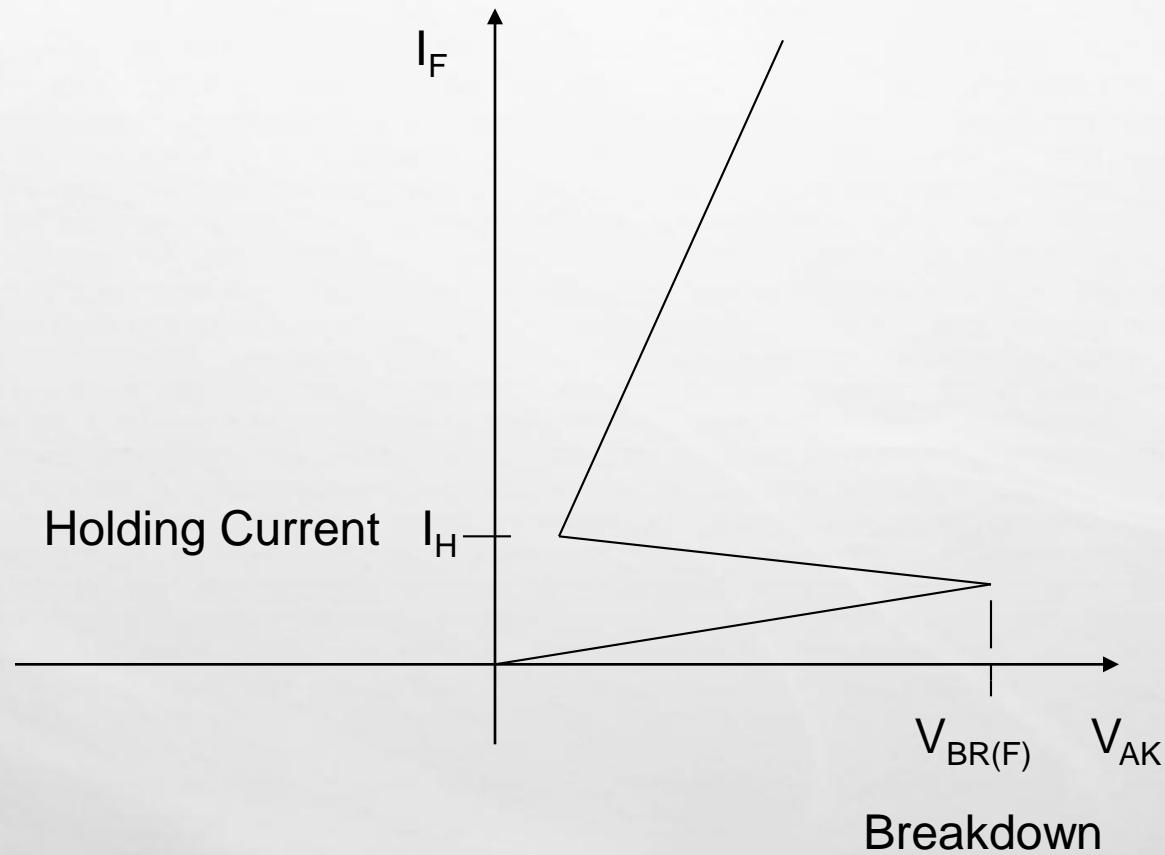
$$I_K = I_g + I_A$$

$$(1-\alpha_1) I_A - I_{CBO1} = \alpha_2 (I_g + I_A) + I_{CBO2}$$

$$(1-(\alpha_1 + \alpha_2)) I_A = \alpha_2 I_g + I_{CBO1} + I_{CBO2}$$

$$I_A = \frac{\alpha_2 I_g + I_{CBO1} + I_{CBO2}}{1 - (\alpha_1 + \alpha_2)}$$

VOLT-AMPERE CHARACTERISTIC



APPLY A GATE CURRENT

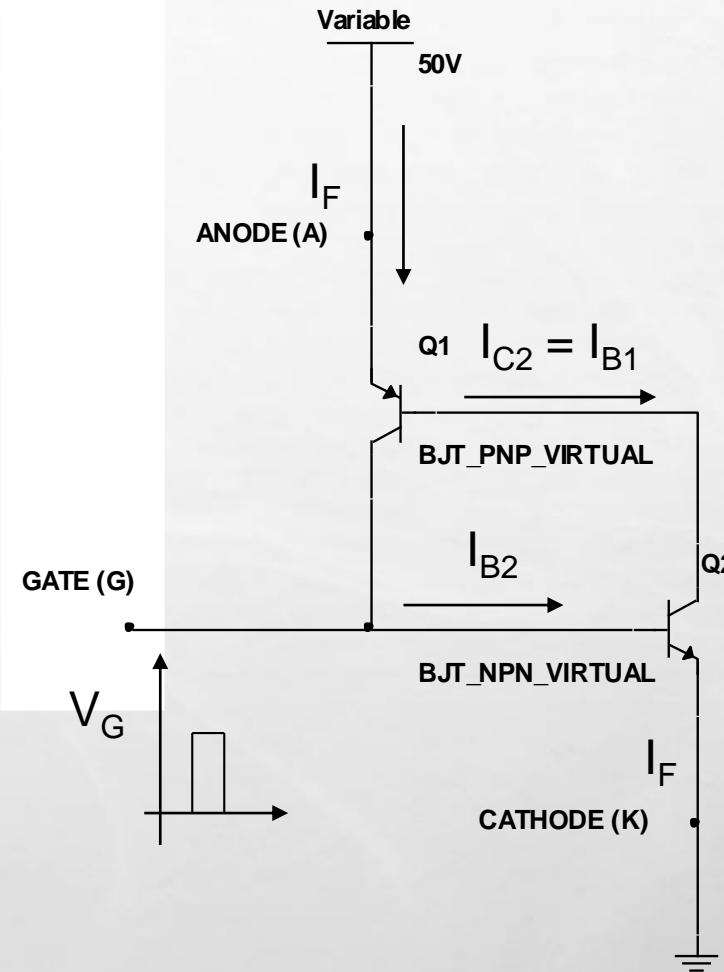
Untuk $0 < V_{AK} < V_{BR(F)}$,

Transistor Q₂ ON dengan mengaktifkan GATE.

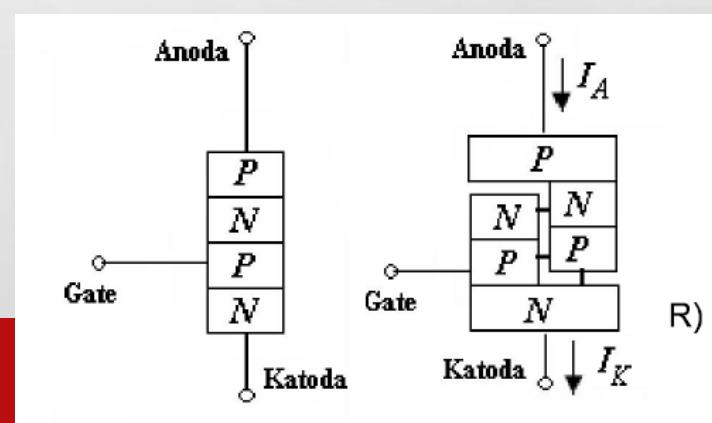
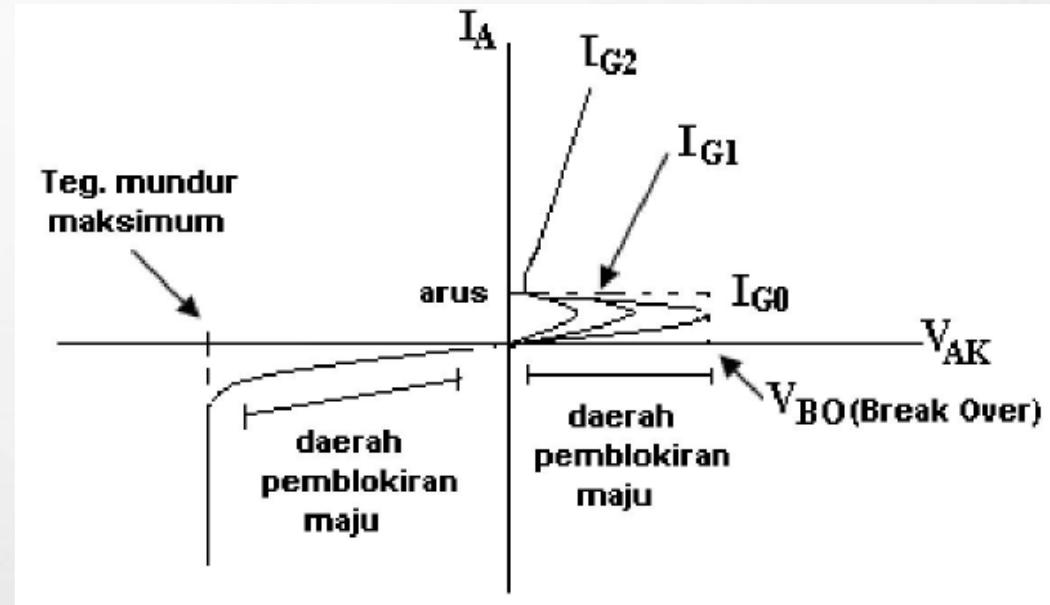
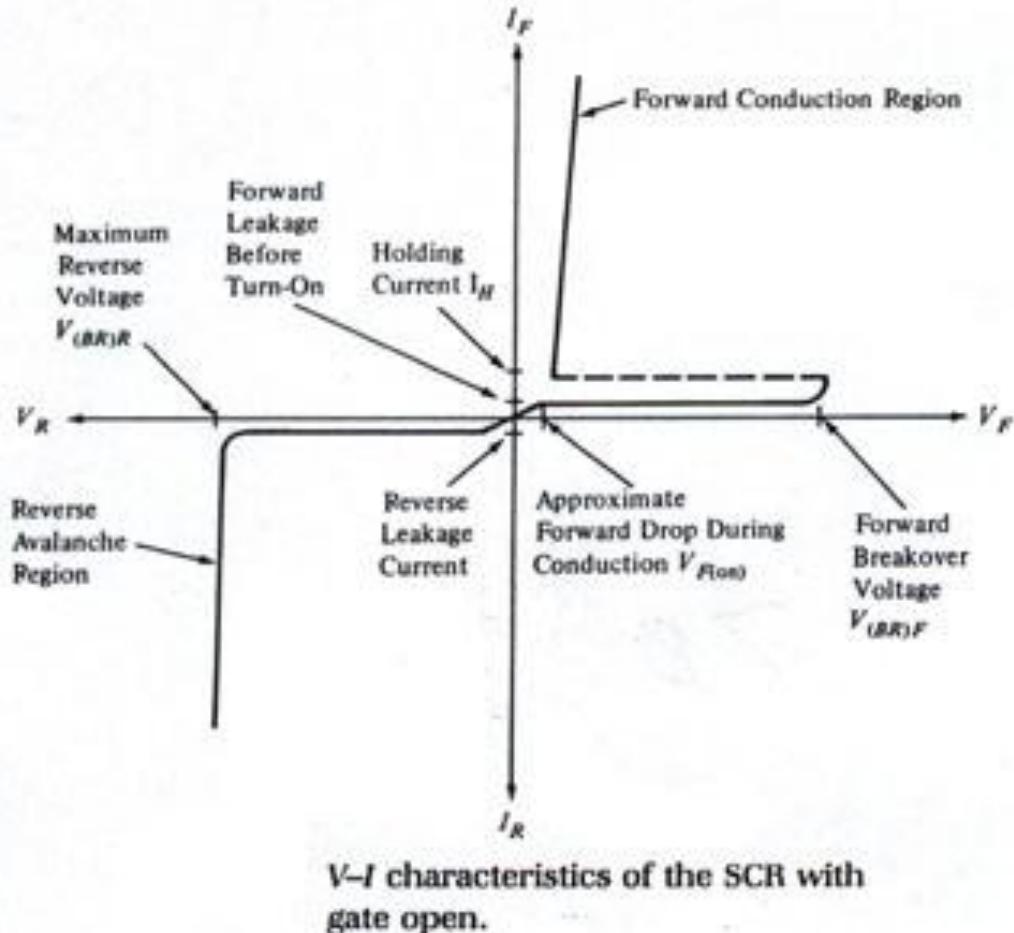
Menyebabkan transistor Q₁ ON, dan secara langsung kedua transistor SATURASI

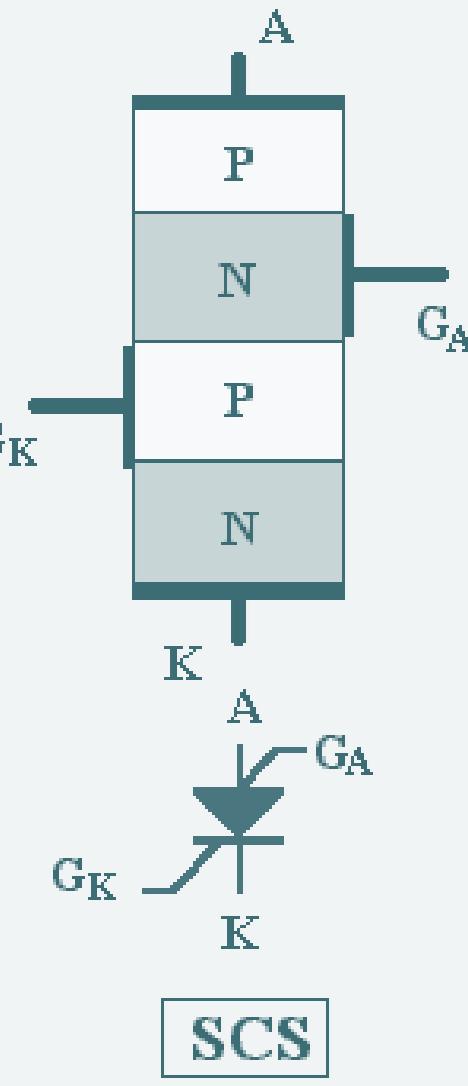
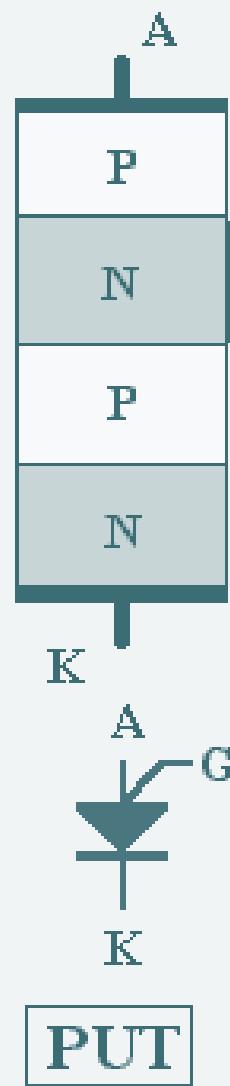
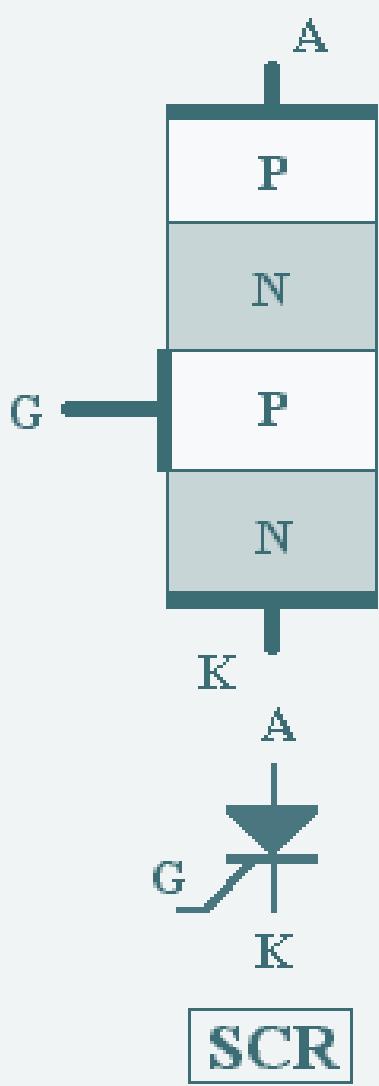
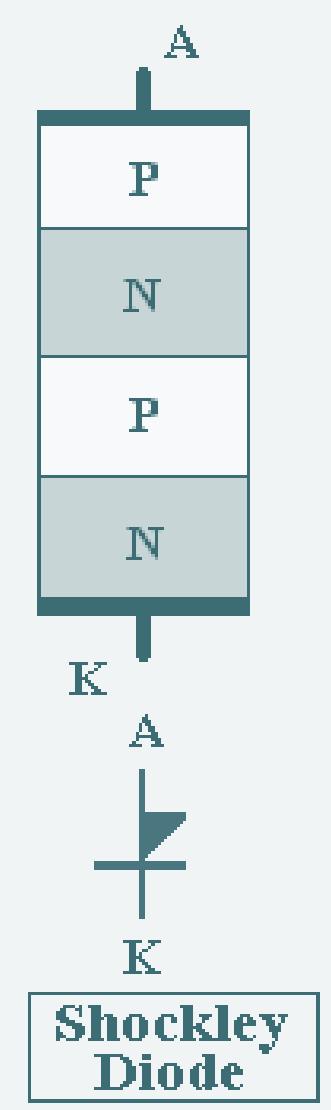
$$V_{AK} = V_{CEsat} + V_{BEsat}$$

Jika pulsa Gate dimatikan, Q_1 and Q_2 masih dalam kondisi ON.



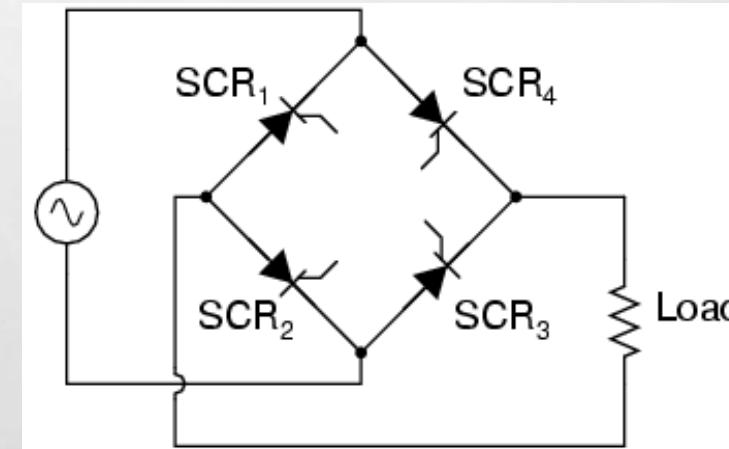
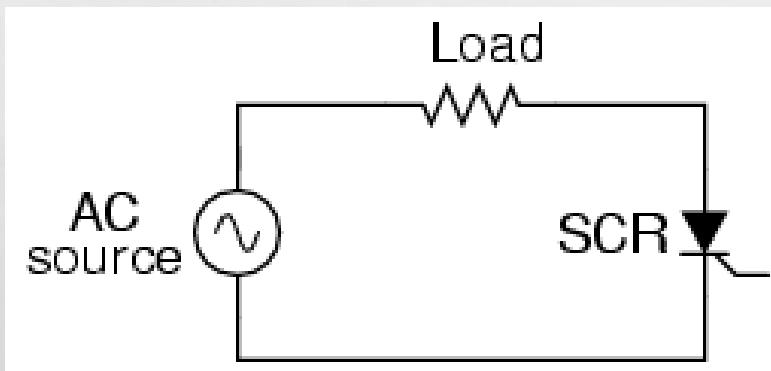
V-I CHARACTERISTIC CURVE



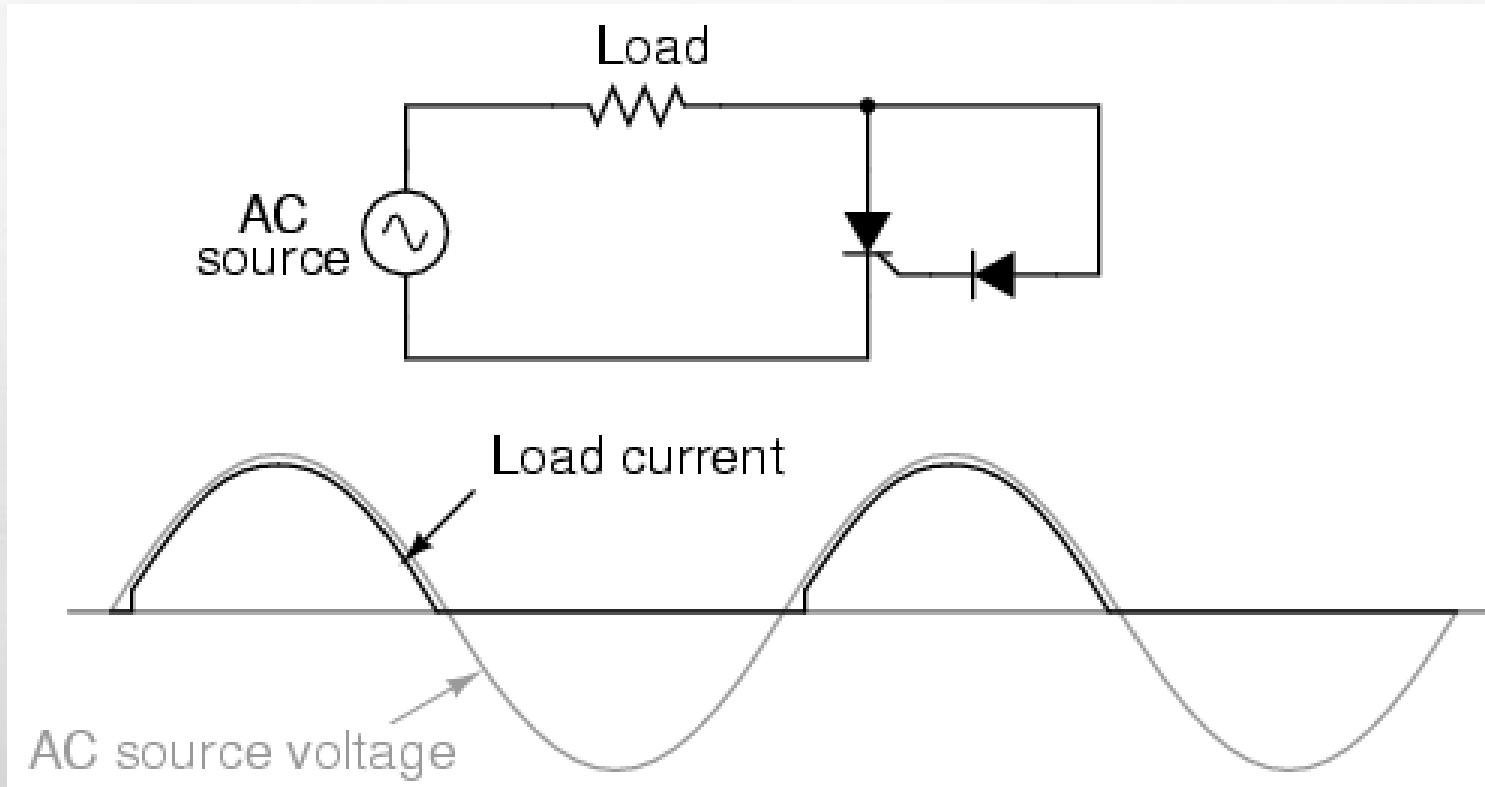


SILICON CONTROLLED RECTIFIER

- DI INDUSTRI SCR DITERAPKAN UNTUK MENGHASILAN TEGANGAN DC PADA APLIKASI MOTOR DC DARI TEGANGAN AC.
- SEBAGAI PENYEARAH (RECTIFIER)
 - *HALF-WAVE DAN FULL-WAVE RECTIFIER*

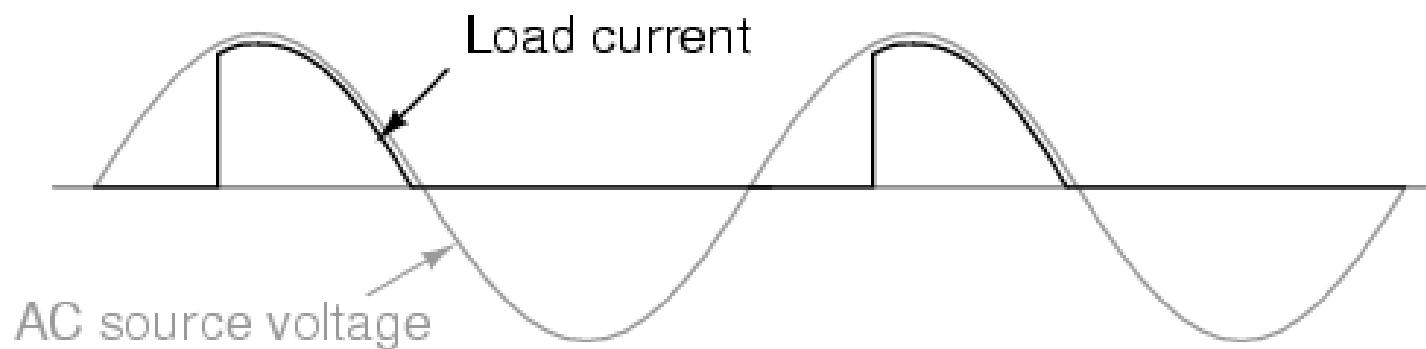
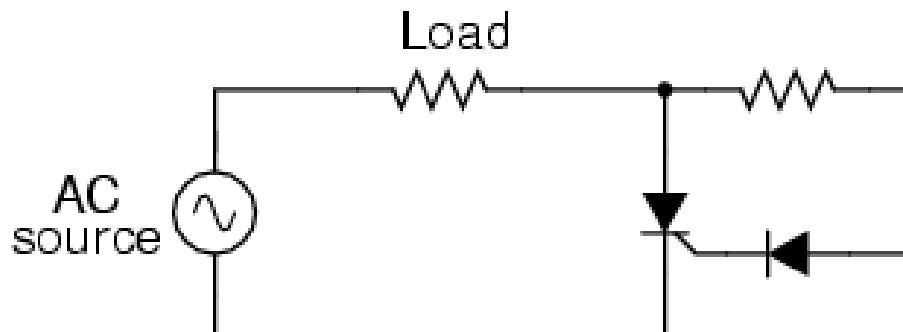


HALF-WAVE RECTIFIER

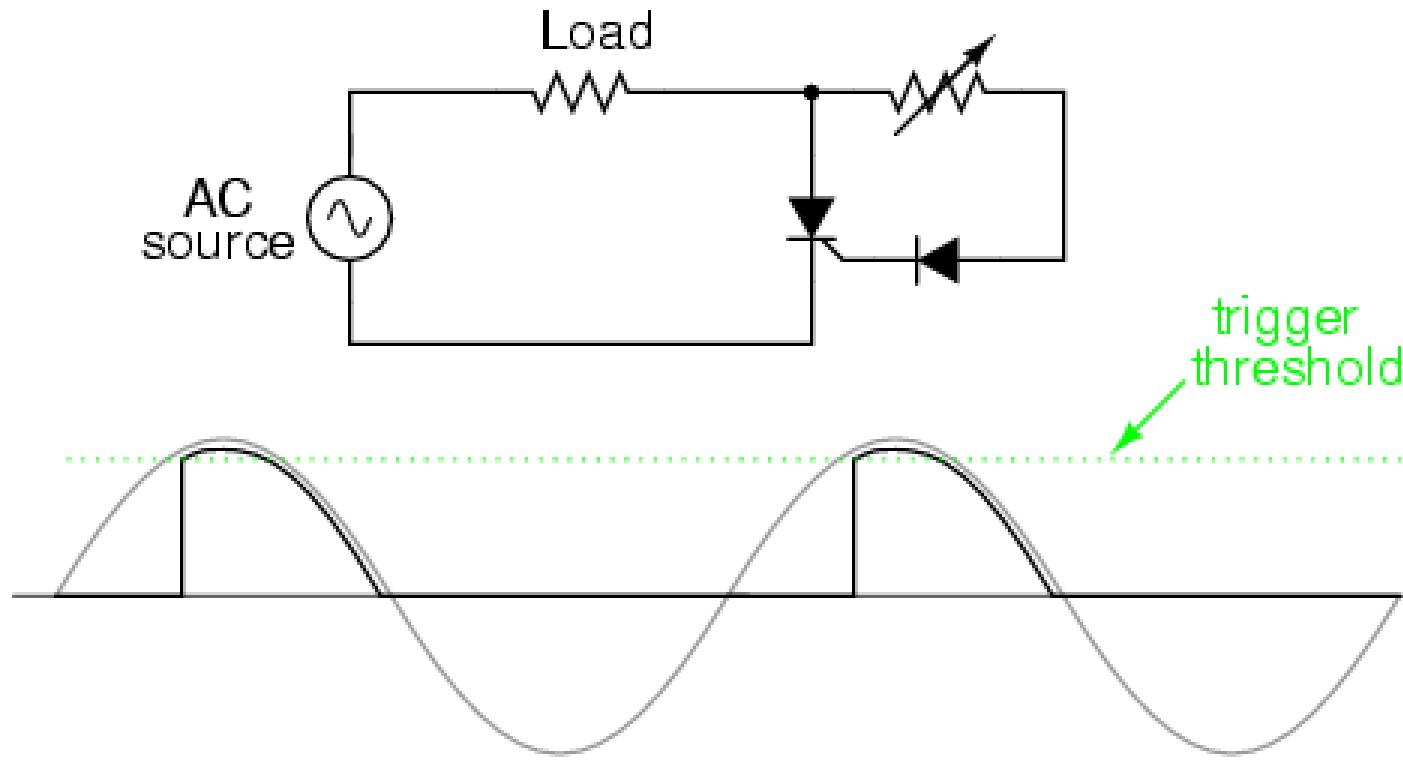


HALF-WAVE RECTIFIER

*Resistance inserted in gate circuit;
less than half-wave current through load*

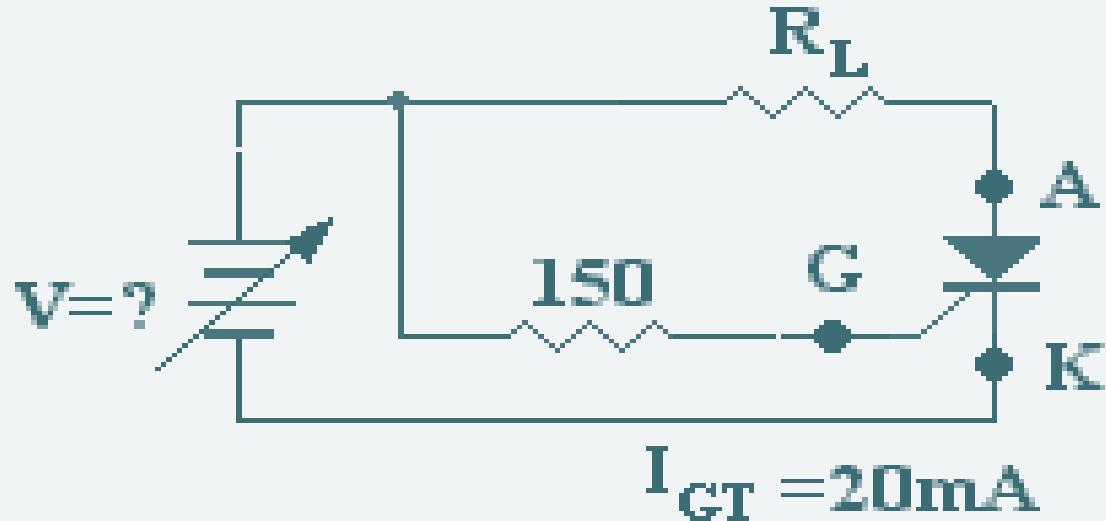


HALF-WAVE RECTIFIER



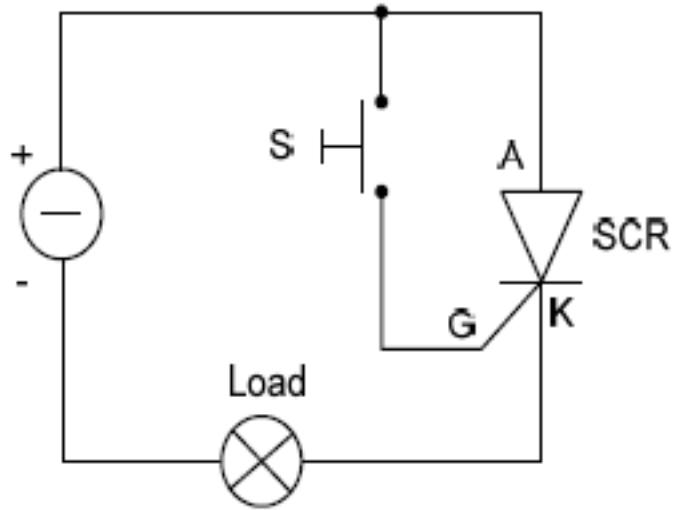
Increasing the resistance raises the threshold level, causing less power to be delivered to the load.

Decreasing the resistance lowers the threshold level, causing more power to be delivered to the load.

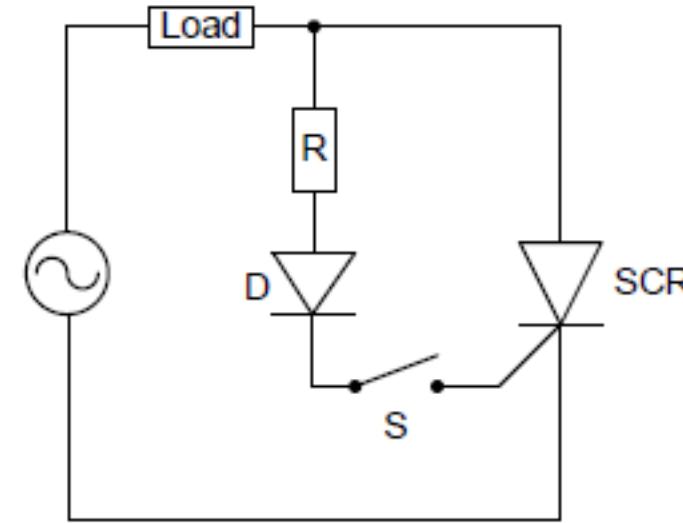


$$I_{GT}=20\text{mA}$$

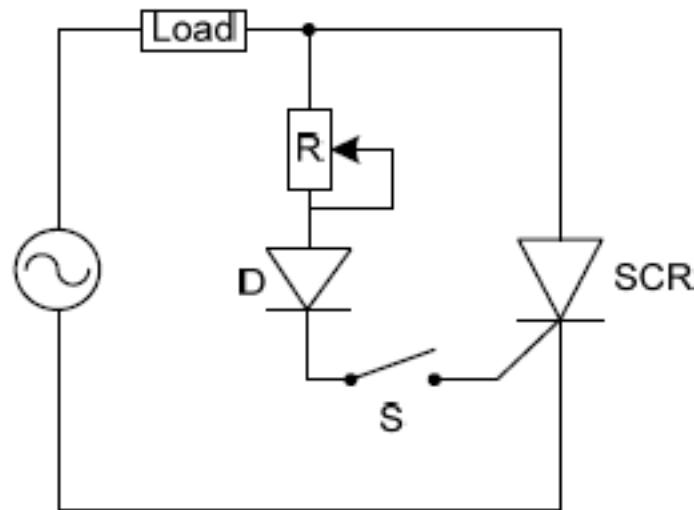
$$V=20\text{m} \times 150 + 0.7 = 3.7\text{V} .$$



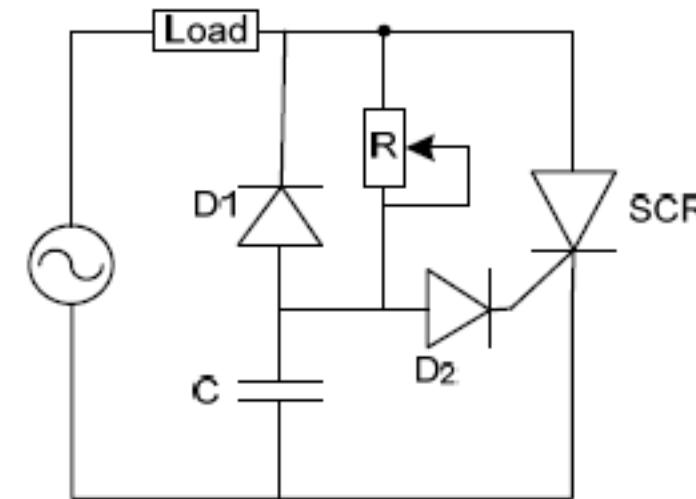
(a)



(b)

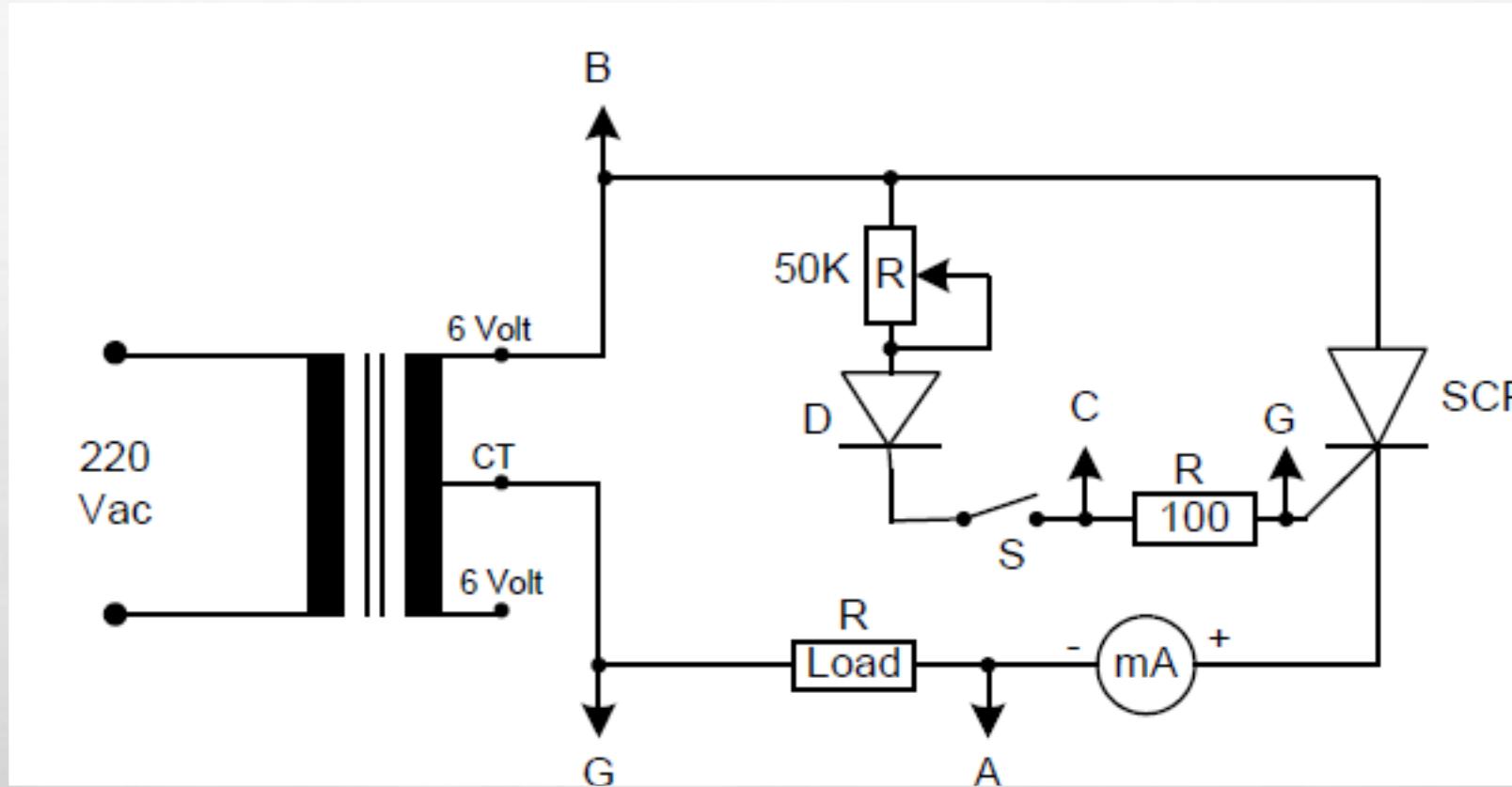


(c)

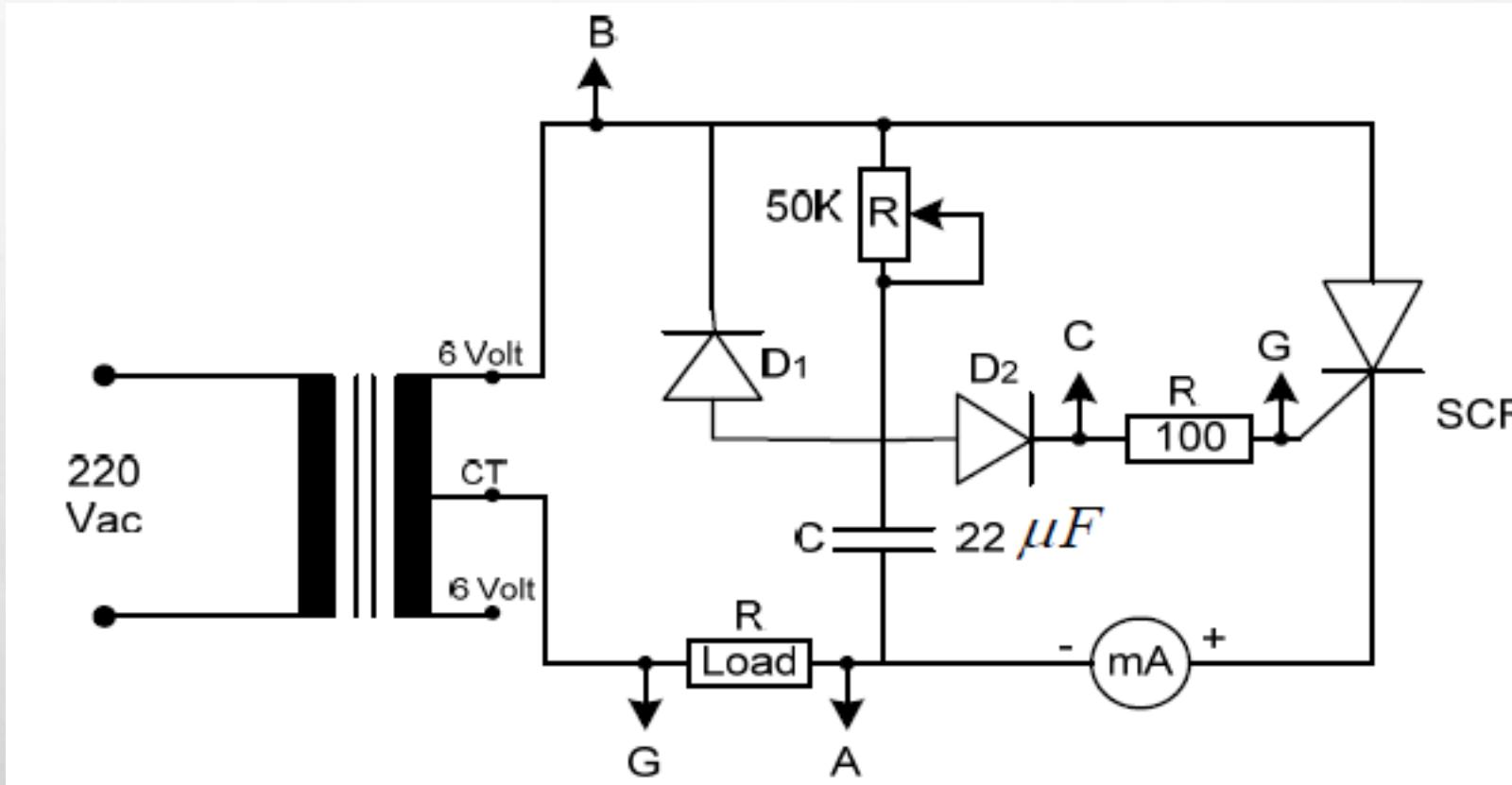


(d)

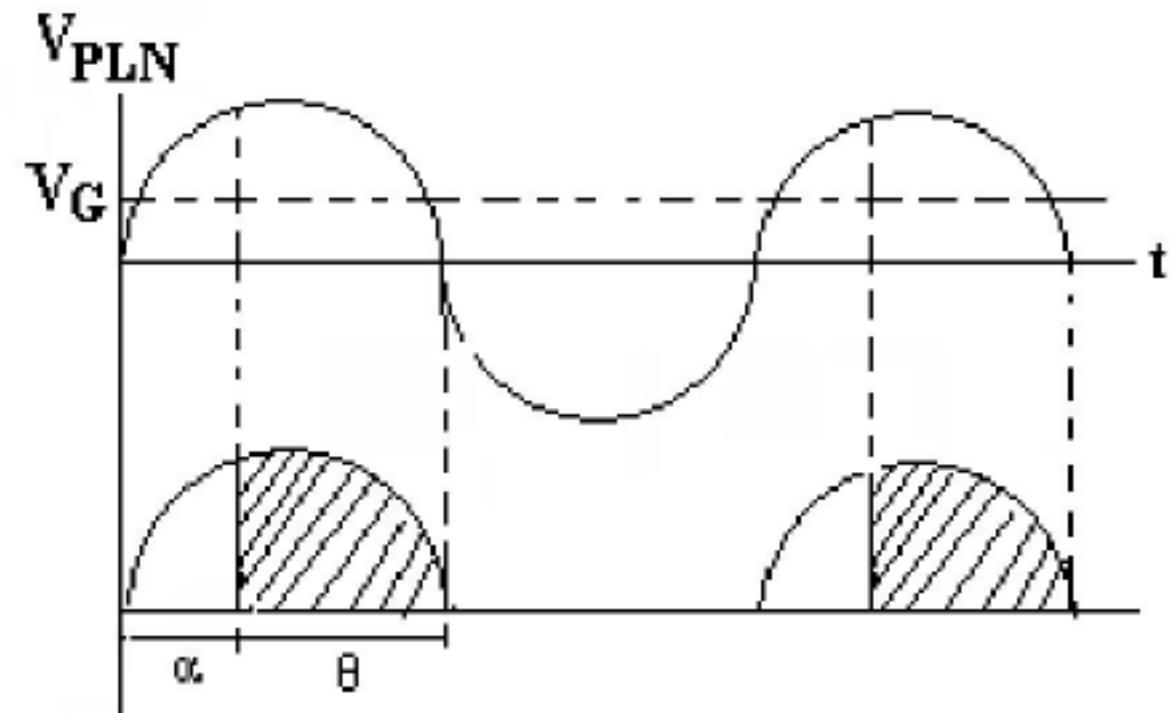
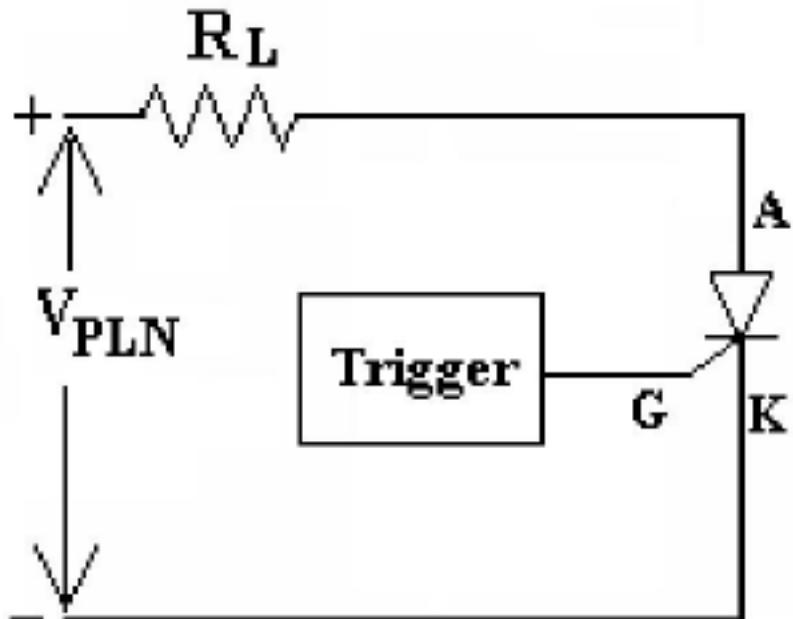
APLIKASI SCR



APLIKASI SCR 2



KONTROL FASA



$$\begin{aligned}V_{\text{rata-rata}} &= \frac{1}{2\pi} \int_{\alpha}^{\pi} V_m \sin \omega t (d\omega t) \\&= -\frac{V_m}{2\pi} [\cos \omega t]_{\alpha}^{\pi} \\&= -\frac{V_m}{2\pi} (\cos \pi - \cos \alpha)\end{aligned}$$

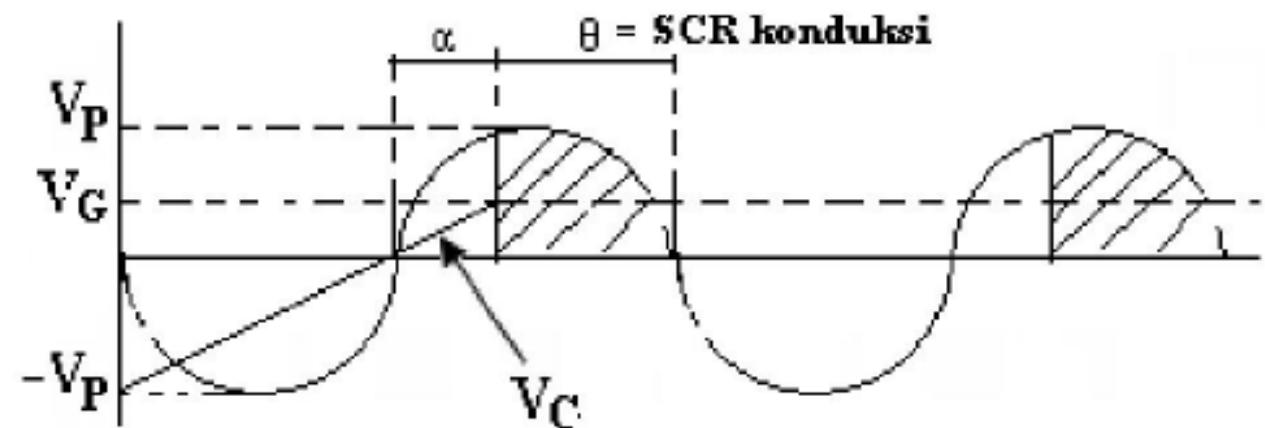
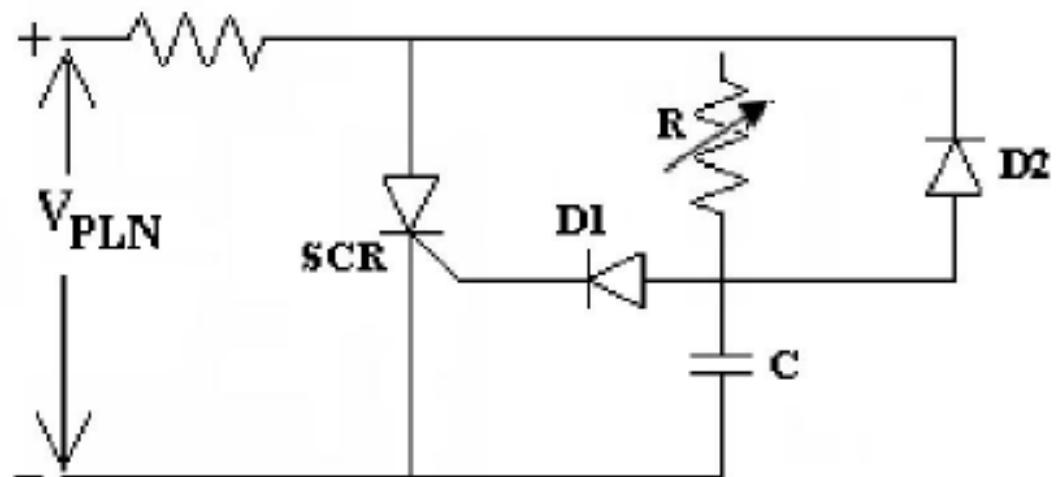
$$V_{\text{rata-rata}} = \frac{V_m}{2\pi} (\cos \alpha + 1)$$

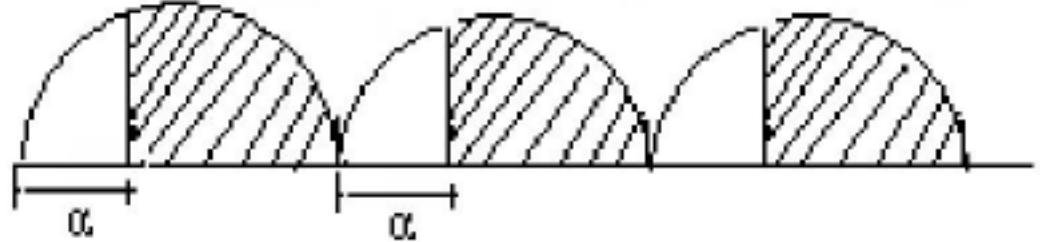
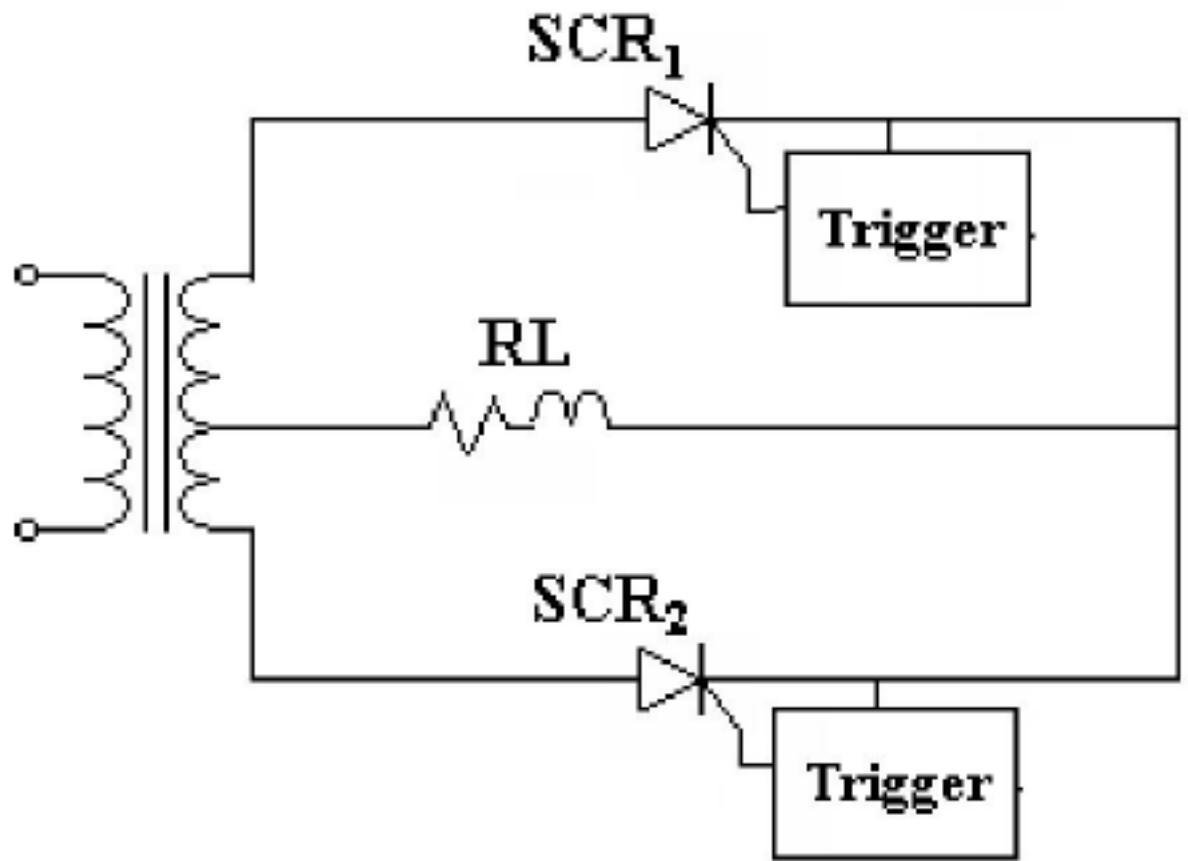
(tegangan keluaran bisa diatur sesuai dengan harga α)

α berkisar dari 0° sampai dengan 180°

untuk $\alpha = 0^\circ, \theta = 180^\circ, \alpha = 180^\circ, \theta = 0^\circ$

RANGKAIAN PICU

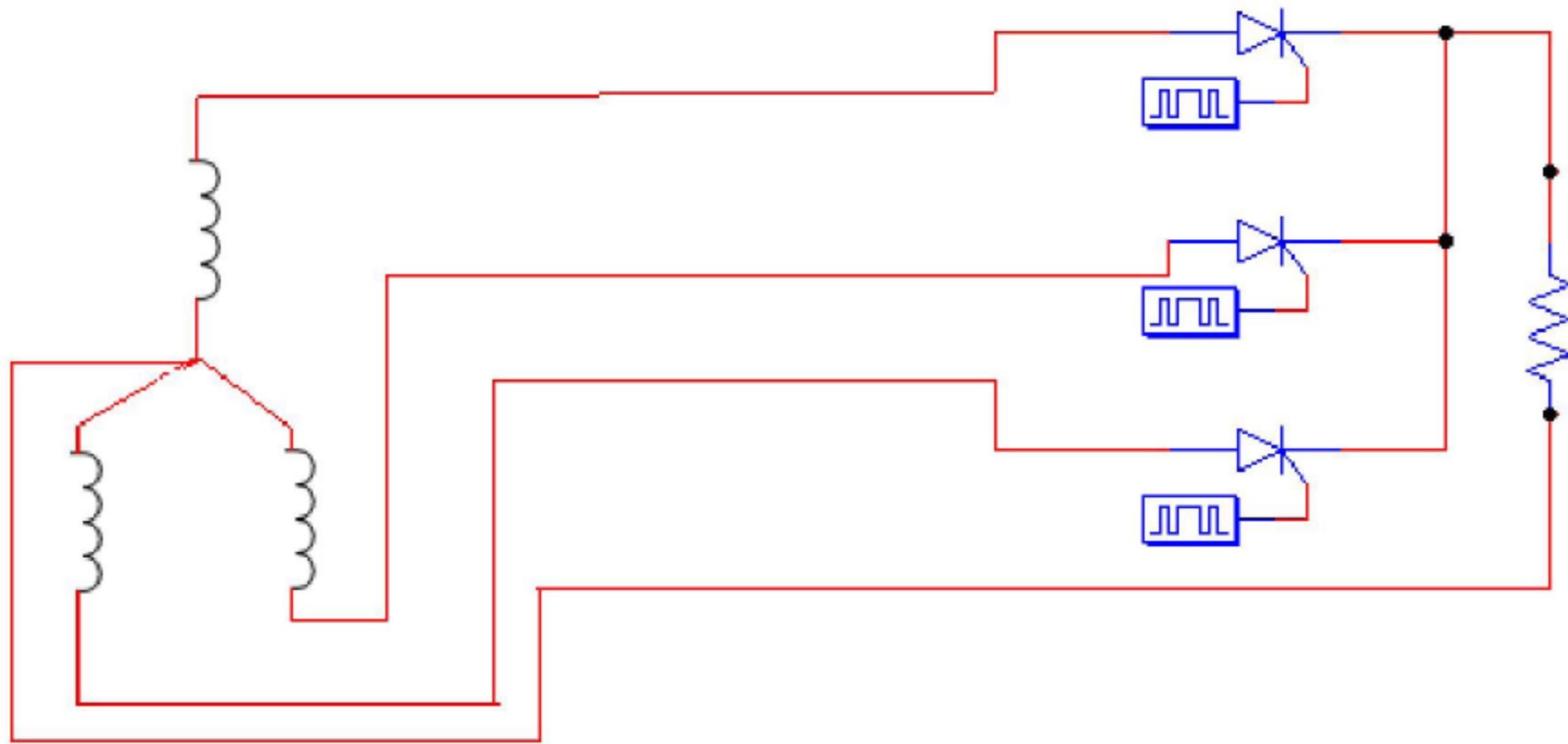




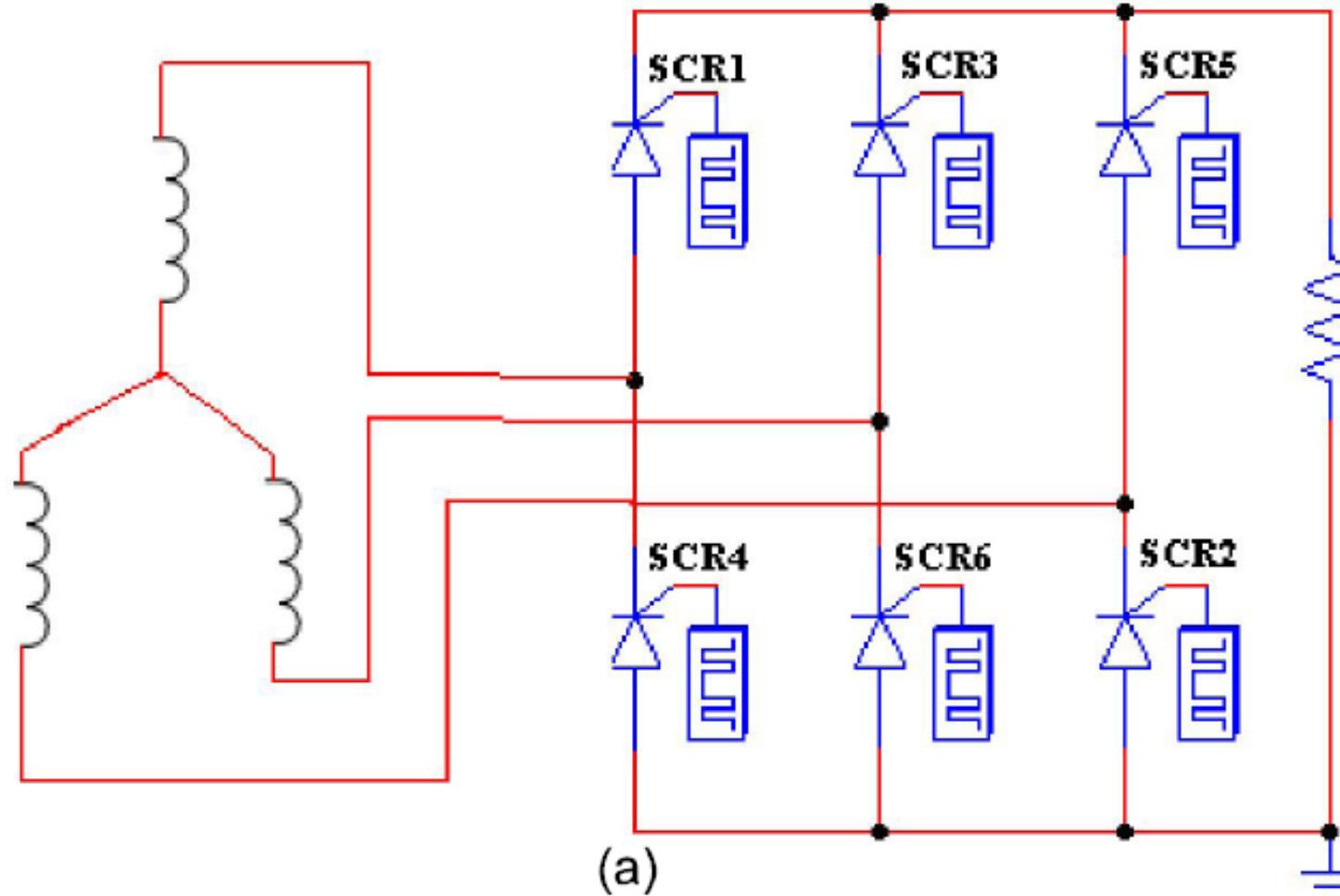
$$V_{\text{rata-rata}} = \frac{1}{\pi} \int_{\alpha}^{\pi} V_m \sin \omega t d(\omega t)$$

$$= \frac{Em}{\pi} (1 + \cos \alpha)$$

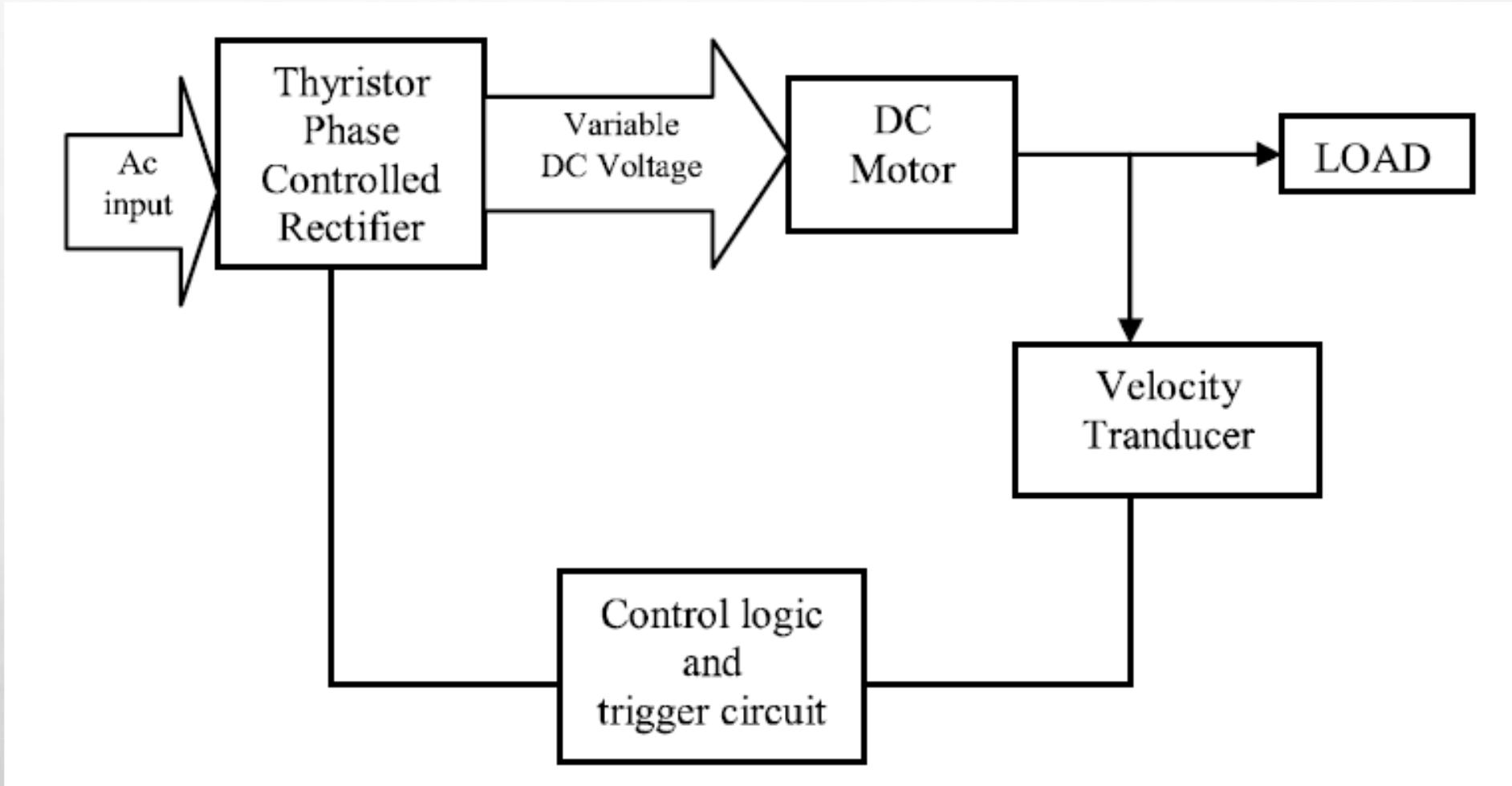
PENYEARAH GELOMBANG 3 FASA



PENYEARAH PENUH GELOMBANG 3 FASA



APLIKASI



APLIKASI: DC MOTOR DRIVER

- KECEPATAN MOTOR DC SECARA UMUM TERGANTUNG DARI KOMBINASI TEGANGAN DAN ARS YANG MENGALIR PADA COIL MOTOR DAN BEBAN MOTOR ATAU TORSI.
- KECEPATAN MOTOR PROPORSIONAL TERHADAP TEGANGAN, TORSI PROPORSIONAL TERHADAP ARUS.

DRIVER ARUS MOTOR DC

- PENYEARAH (*RECTIFIER*) MERUPAKAN SATU ATAU LEBIH DIODE YANG DISUSUN UNTUK MENGKONVERSI AC KE DC.
- ARUS YANG DIGUNAKAN UNTUK MEN-DRIVE MOTOR DC BIASANYA BERASAL DARI:

FIXED VOLTAGE:

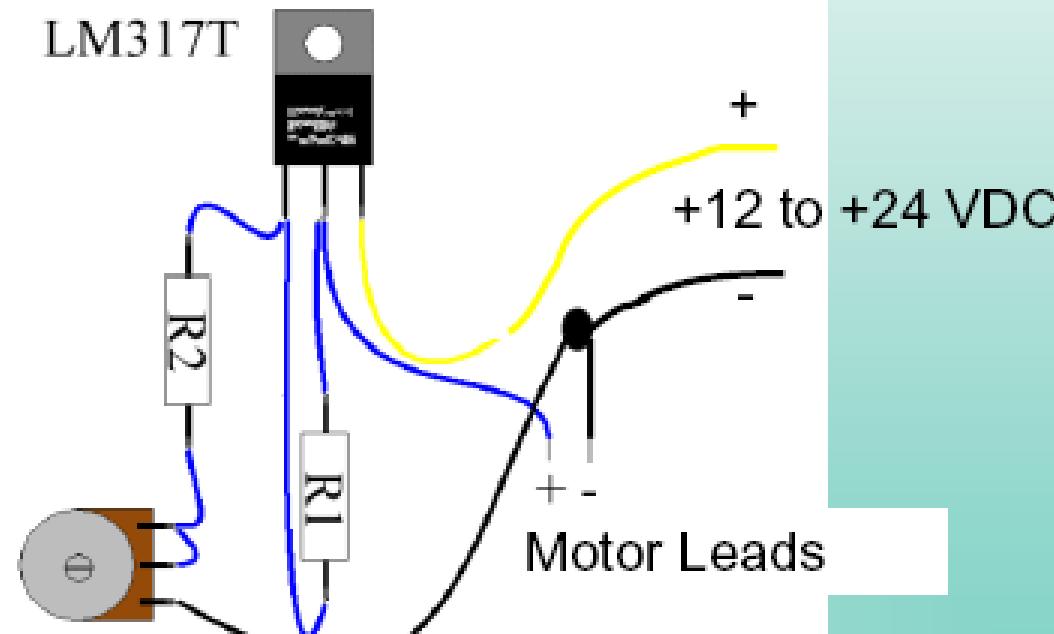
- BATTERY
- VOLTAGE REGULATOR

ADJUSTABLE VOLTAGE:

- SUMBER ARUS PWM
- SCR MODULATED AC SOURCE

DC MOTORS CURRENT DRIVES

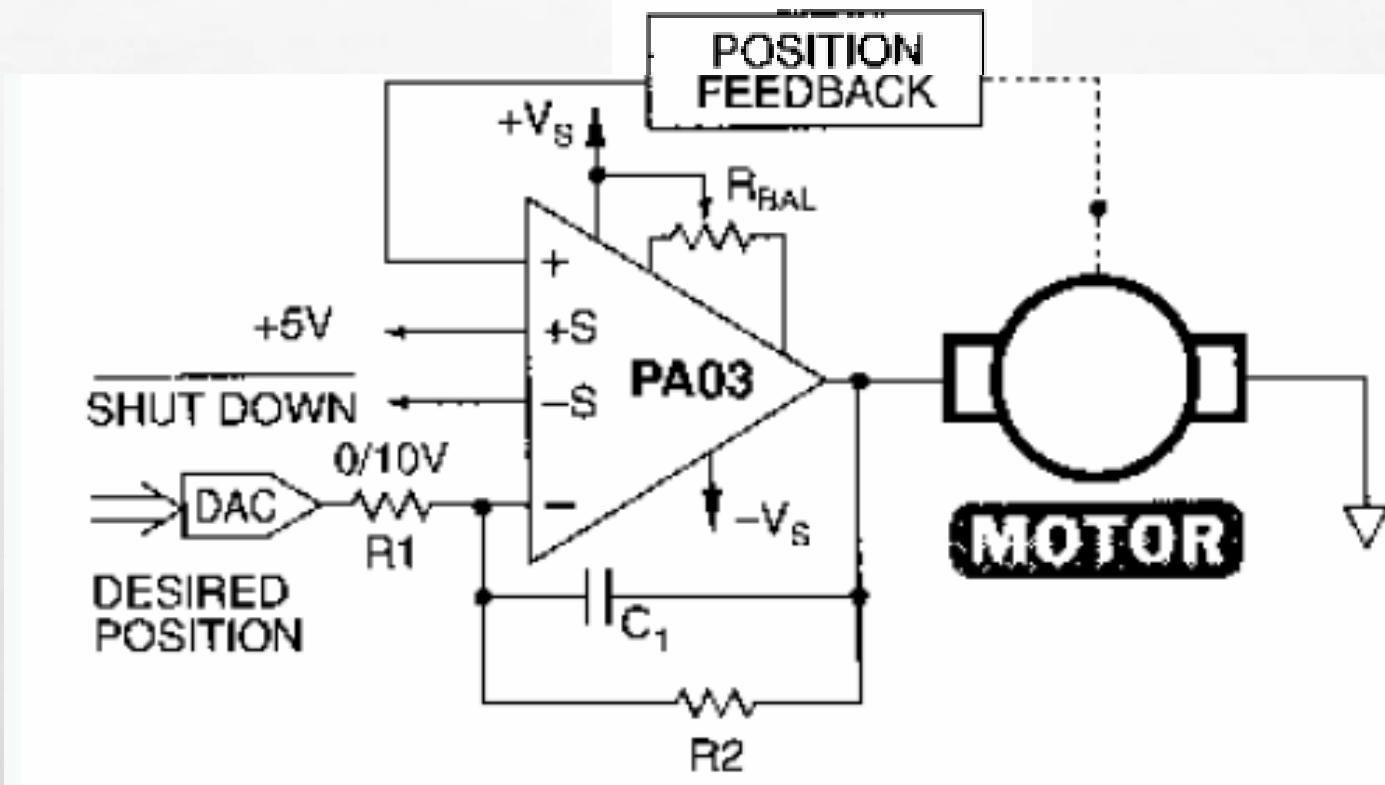
$R_1 = 260\Omega$
 $R_2 = 1k\Omega$



1 k Ω potentiometer

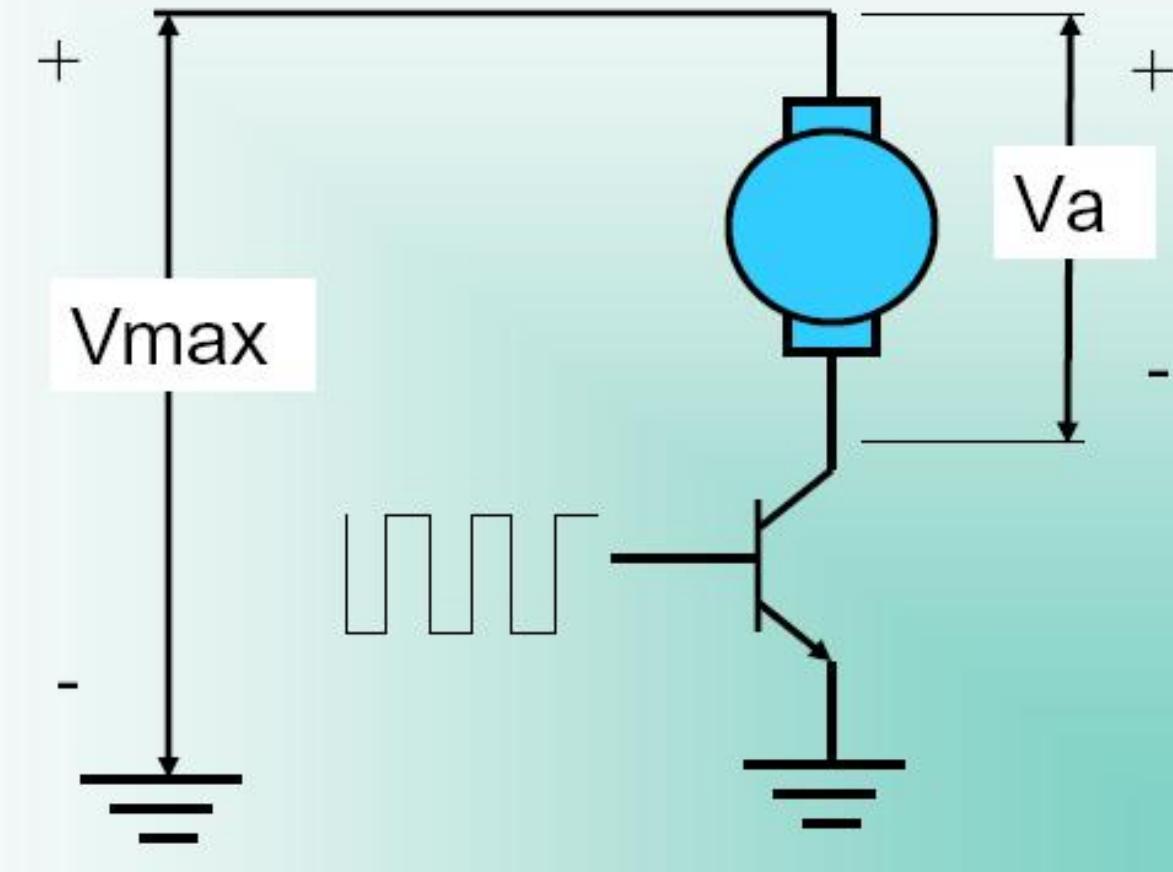
- VOLTAGE REGULATOR

DC MOTORS CURRENT DRIVES



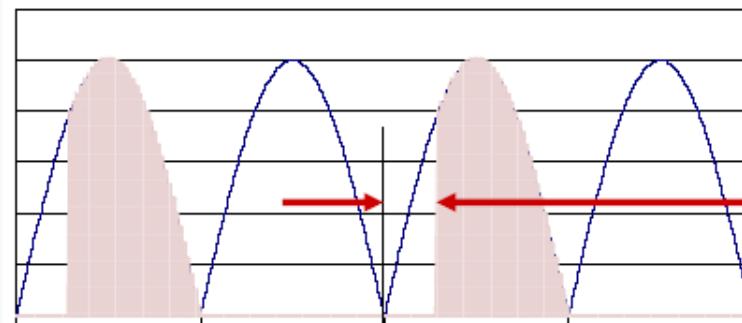
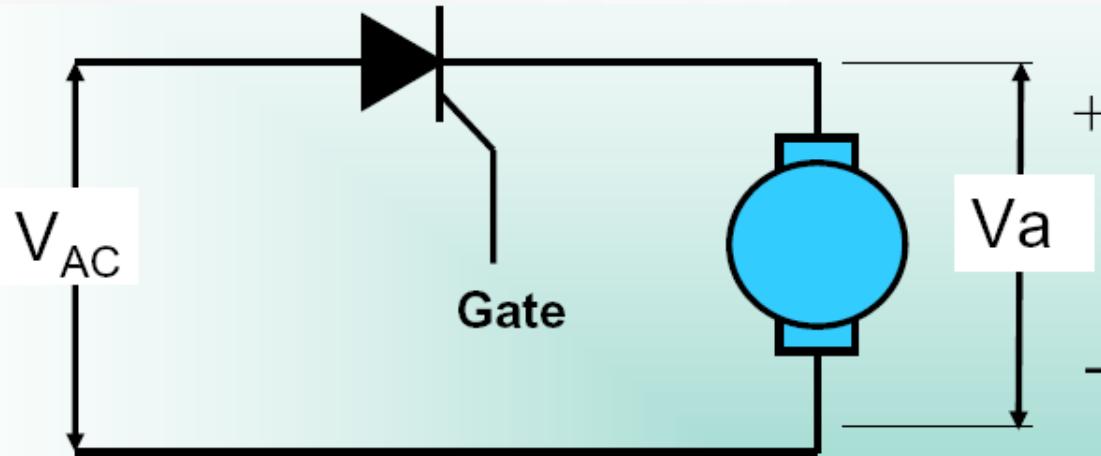
- LINEAR POWER TRANSISTOR & OP AMP

DC MOTORS CURRENT DRIVES



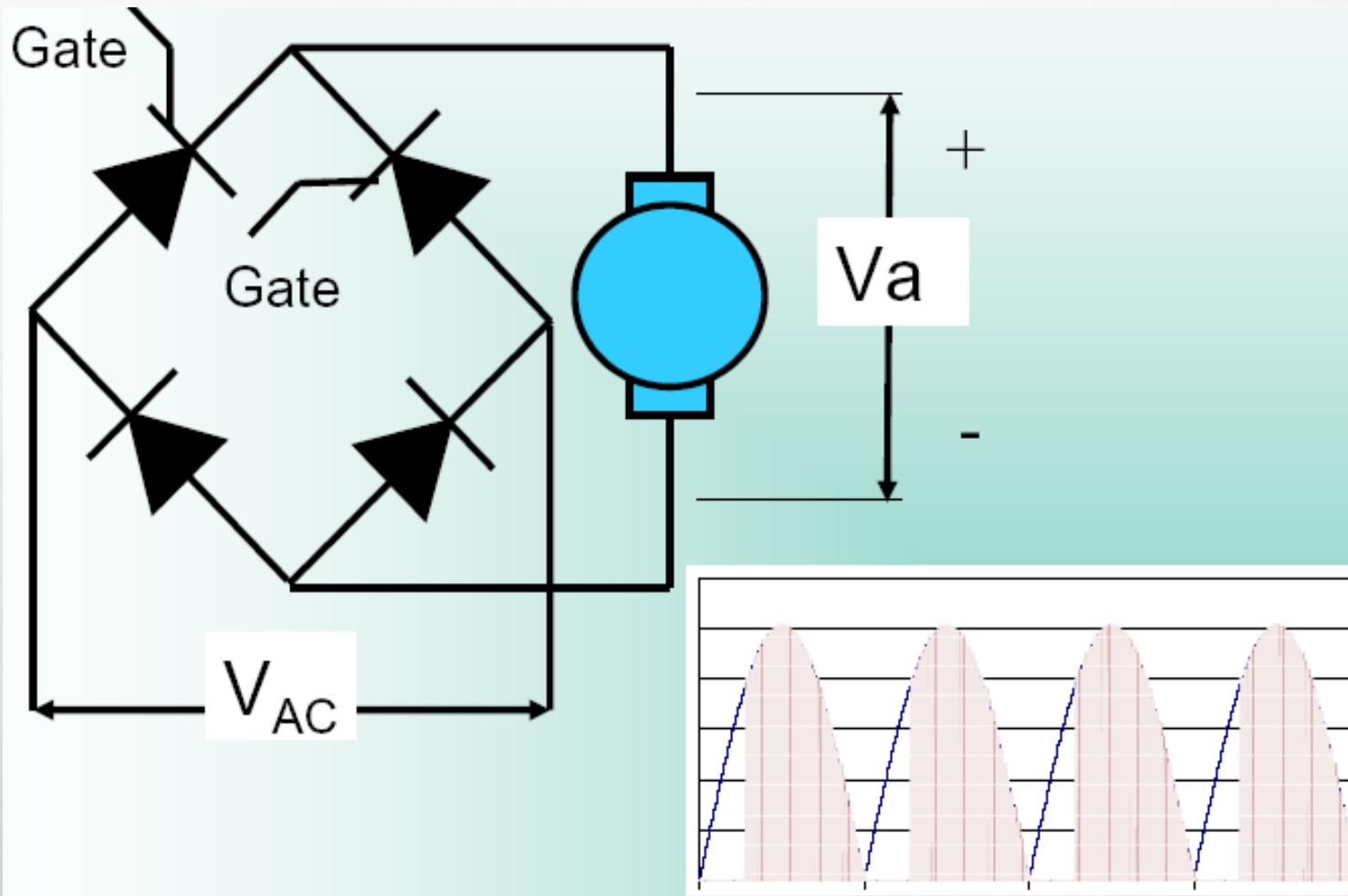
- PULSE WIDTH MODULATION

DC MOTORS CURRENT DRIVES

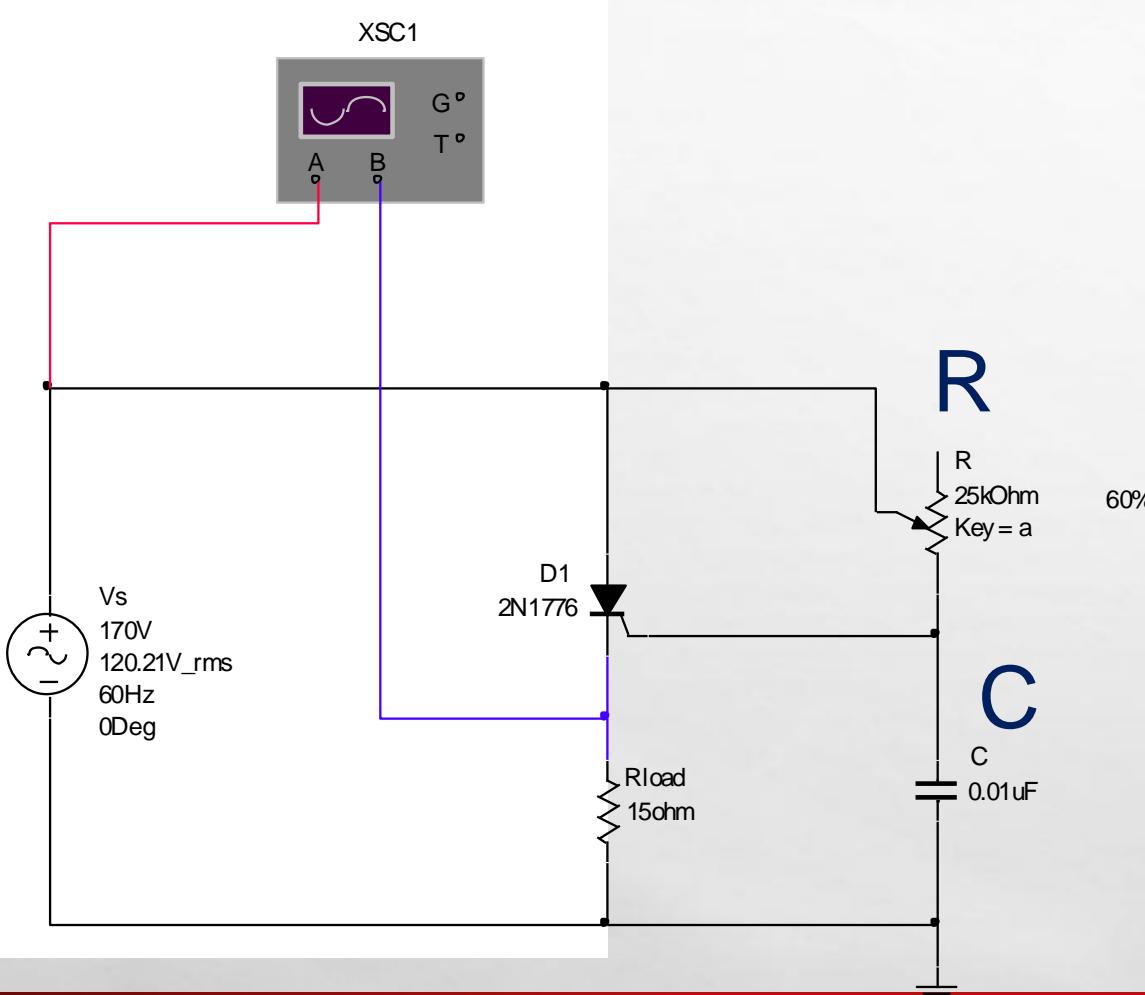


Delay time is
adjustable by
gate signal

DC MOTORS CURRENT DRIVES



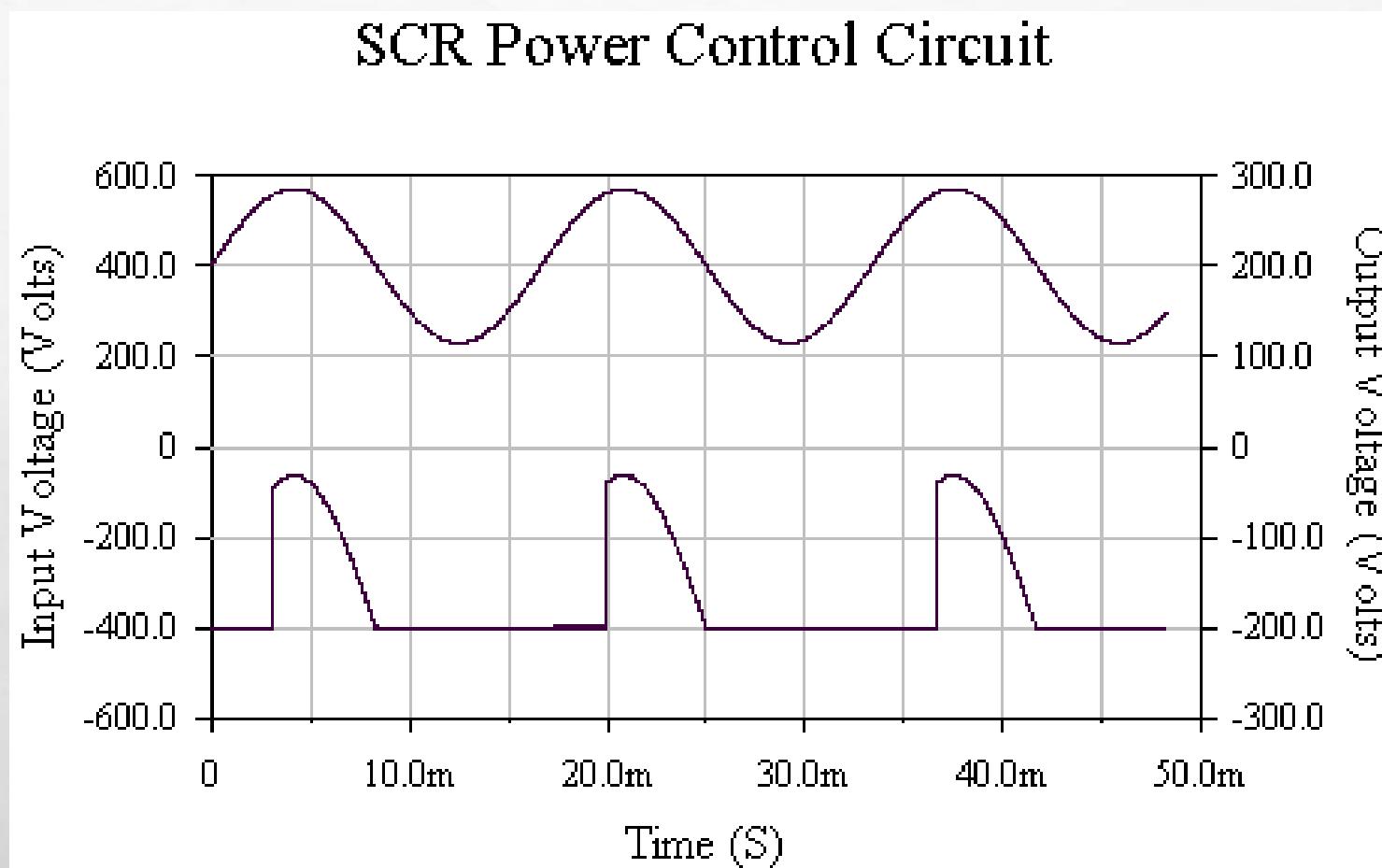
APLIKASI SCR – POWER CONTROL



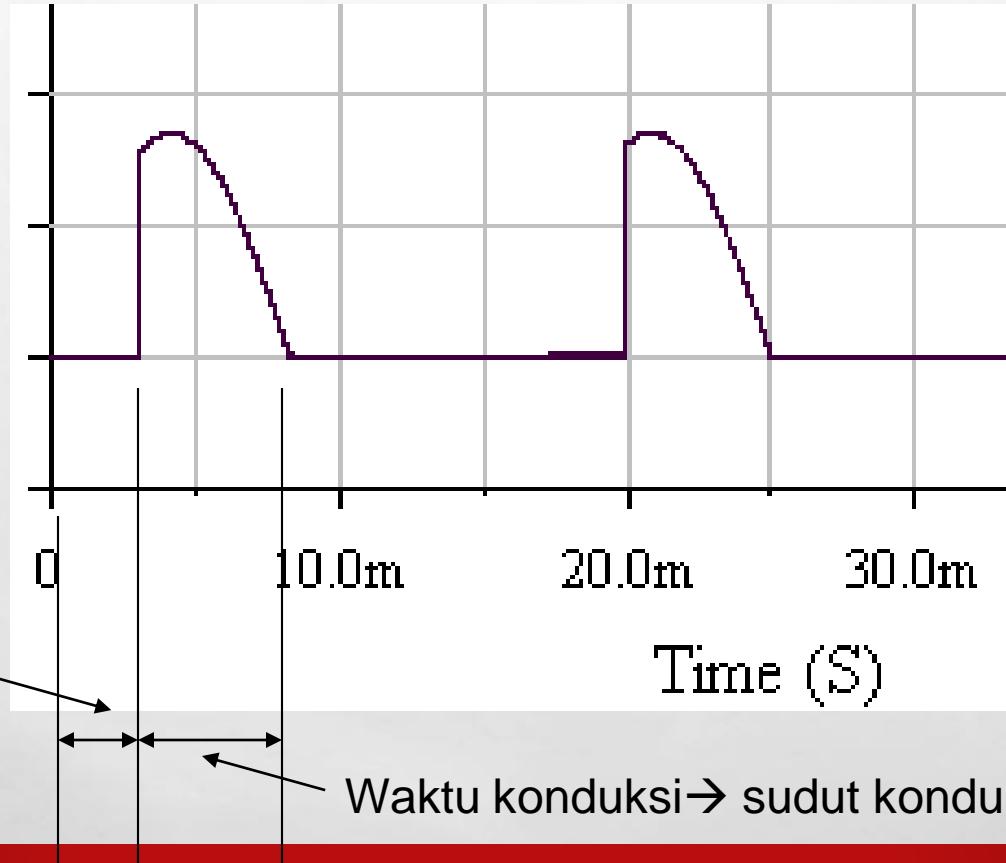
Ketika tegangan yang melalui kapasitor mencapai tegangan “trigger-point”, menyebabkan SCR aktif ‘ON’; arus mengalir pada beban untuk separuh siklus positif..

Aliran arus akan berhenti ketika siklus tegangan negatif.

TEGANGAN INPUT-OUTPUT



LOAD CURRENT



Waktu penyalaan

→ sudut pengapian (α)

Waktu konduksi → sudut konduksi= $180^\circ - \alpha$

AVERAGE LOAD CURRENT

$$i_{L,AVE} = \frac{1}{2\pi} \int_{-\alpha}^{\pi} \frac{V}{R_{LOAD}} \sin \omega t d(\omega t)$$

$$i_{L,AVE} = \frac{V}{2\pi R_L} (1 + \cos \alpha)$$

$$\alpha = -\tan^{-1}(\omega R C)$$