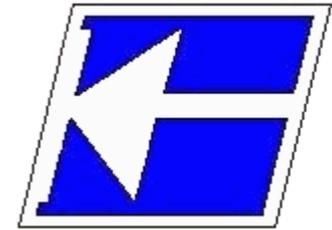


Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina

Departamento Acadêmico de Eletrônica

Eletrônica de Potência



Conversores CA-CA

Gradadores e Variadores CA-CA

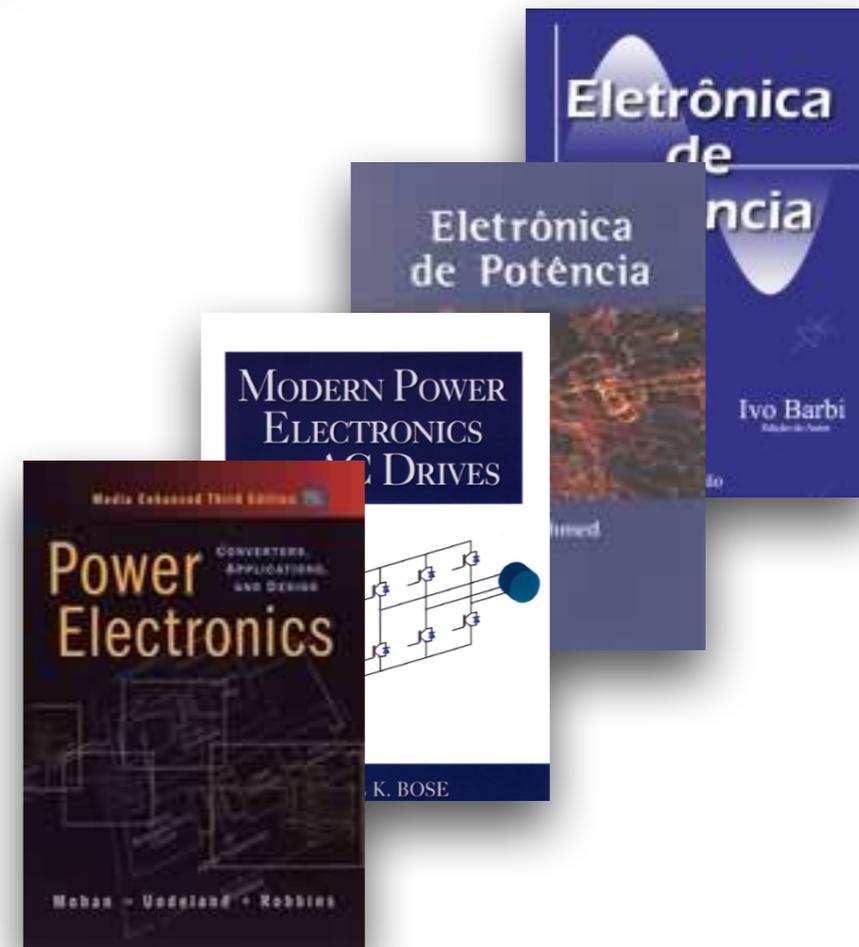
Prof. Clovis Antonio Petry.

Florianópolis, maio de 2020.

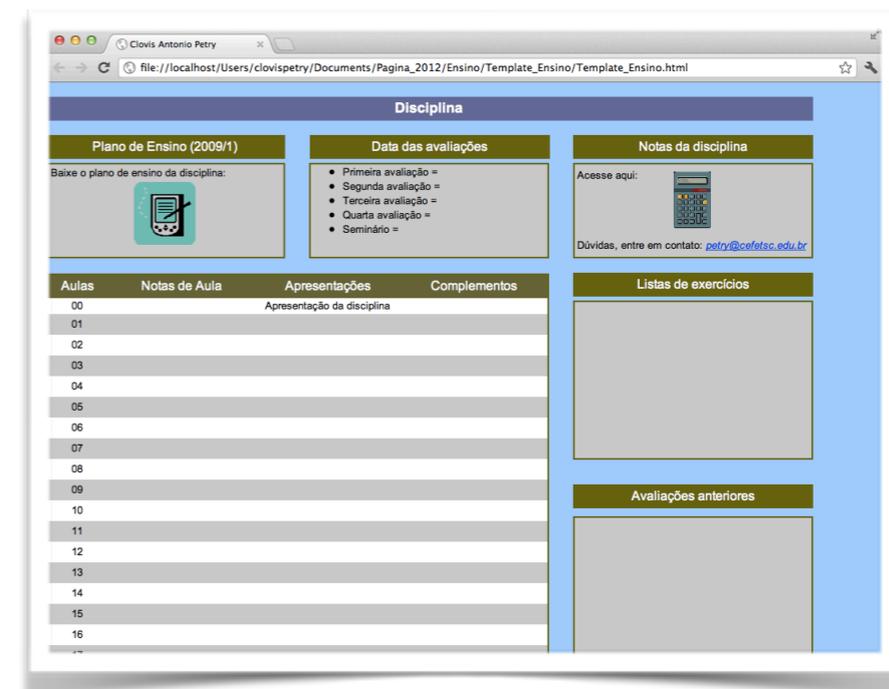
Biografia para Esta Aula

Capítulo 11 - Controlador de tensão AC:

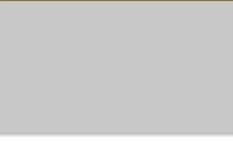
- Gradadores;
- Variadores CA monofásicos.



www.ProfessorPetry.com.br



A screenshot of a web page titled 'Disciplina' (Course). The page is organized into several sections:

- Plano de Ensino (2009/1)**: Baixe o plano de ensino da disciplina: 
- Data das avaliações**:
 - Primeira avaliação =
 - Segunda avaliação =
 - Terceira avaliação =
 - Quarta avaliação =
 - Seminário =
- Notas da disciplina**: Acesse aqui: 
Dúvidas, entre em contato: petry@cefetsc.edu.br
- Table with 4 columns**: Aulas, Notas de Aula, Apresentações, Complementos. The table has 17 rows, with the first row containing '00 Apresentação da disciplina'.
- Listas de exercícios**: 
- Avaliações anteriores**: 

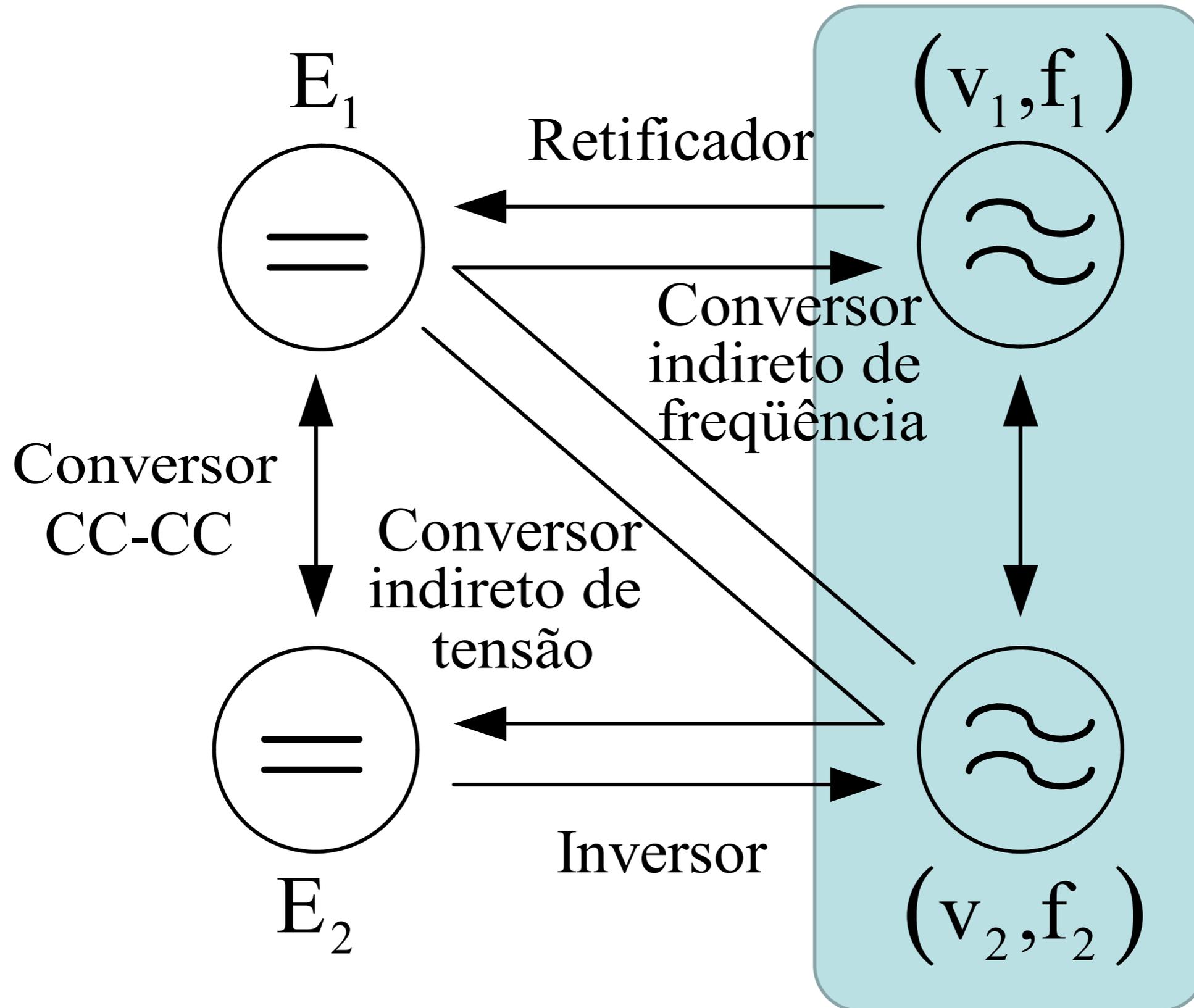
Gradadores:

1. Introdução;
2. Gradadores monofásicos:
 - Carga resistiva;
 - Carga RL.
3. Gradadores trifásicos;
4. Controle por ciclos inteiros;
5. R, L e C controlados por tiristores;
6. Compensador estático de potência reativa.

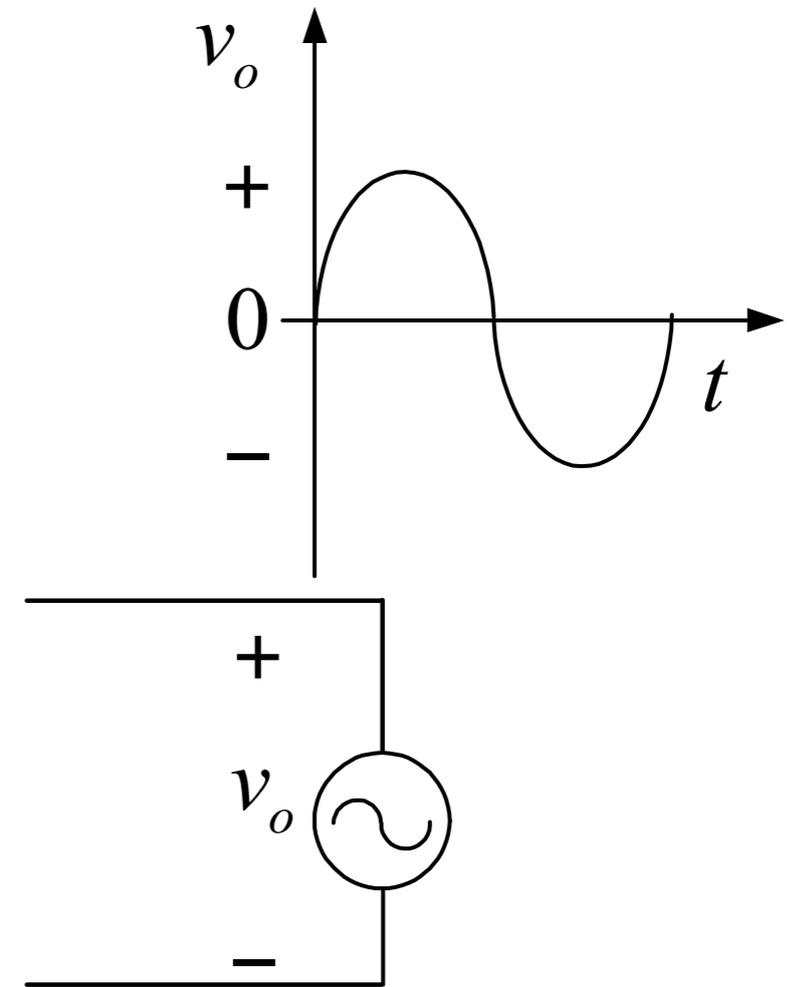
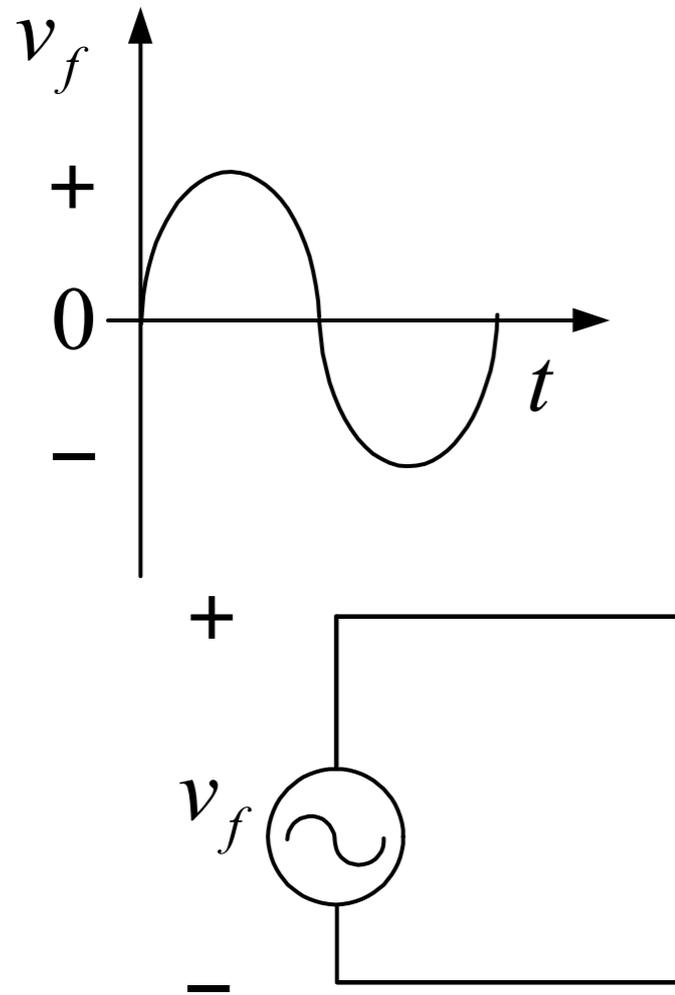
Variadores CA-CA:

1. Introdução;
2. Implementação de um gradador monofásico;
3. Partida de cargas com gradadores;
4. Disparo de tiristores;
5. Chaves bidirecionais para CA-CA;
6. Estabilizadores com tap variável;
7. Chopper CA-CA;
8. Conversor CA-CA indireto.

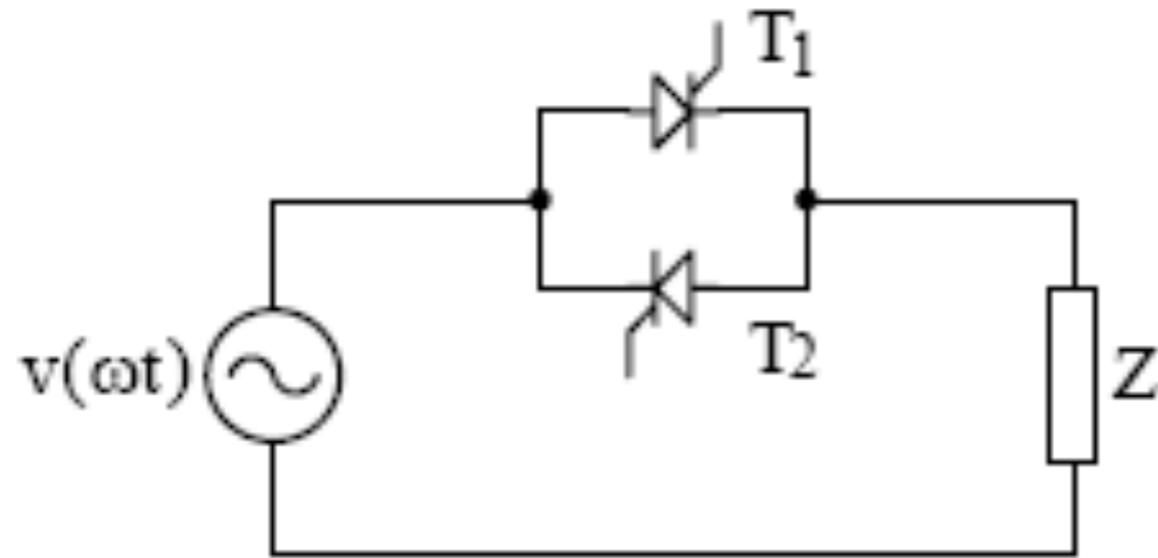
Divisão da Eletrônica de Potência



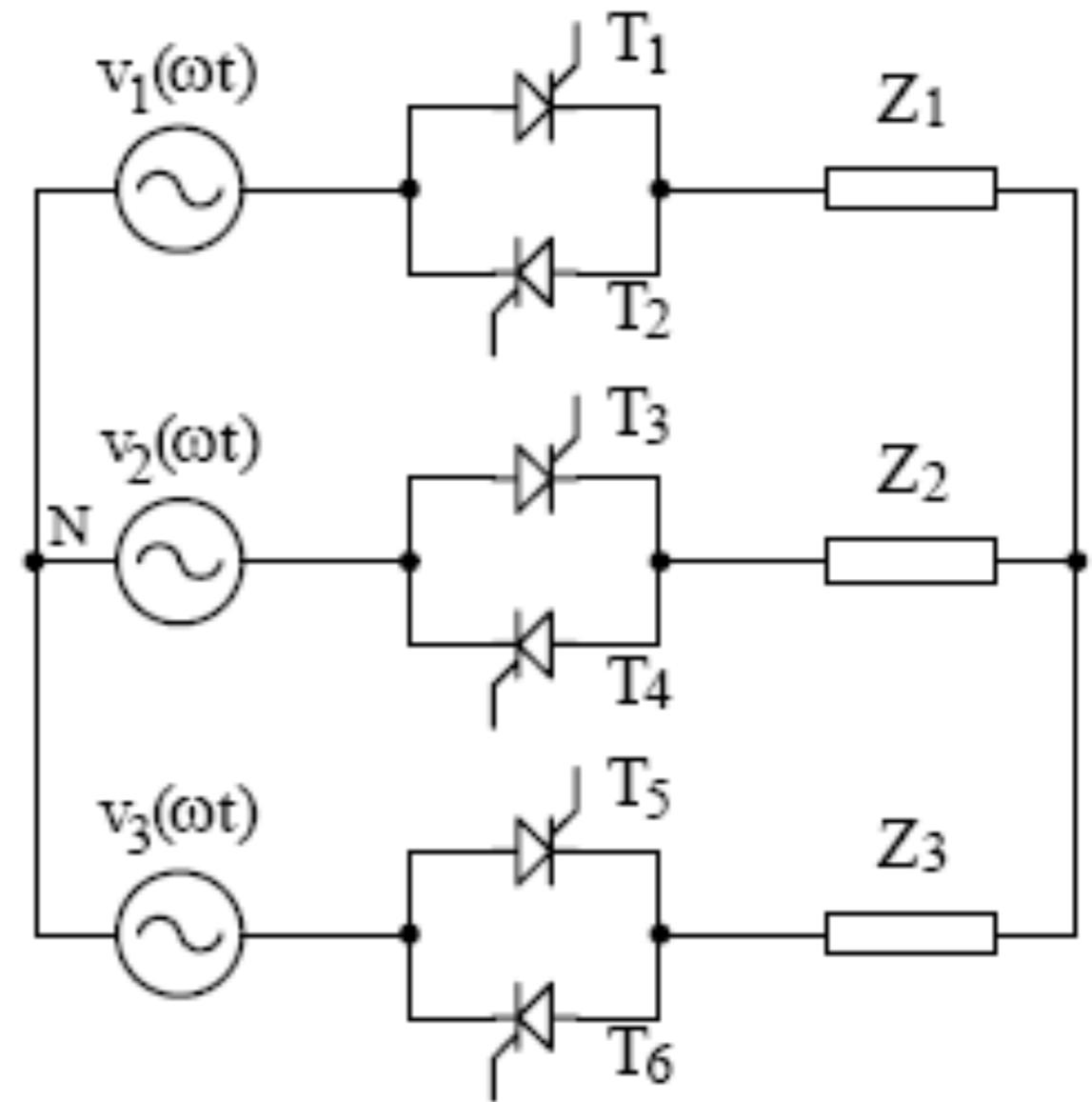
Conversor CA-CA: Princípio Geral



Conversor CA-CA: Numero de Fases

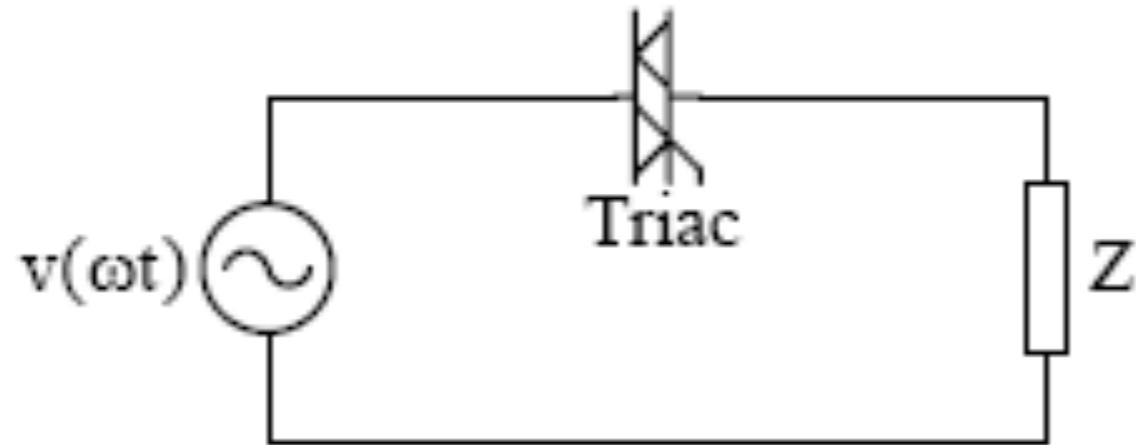


Monofásico

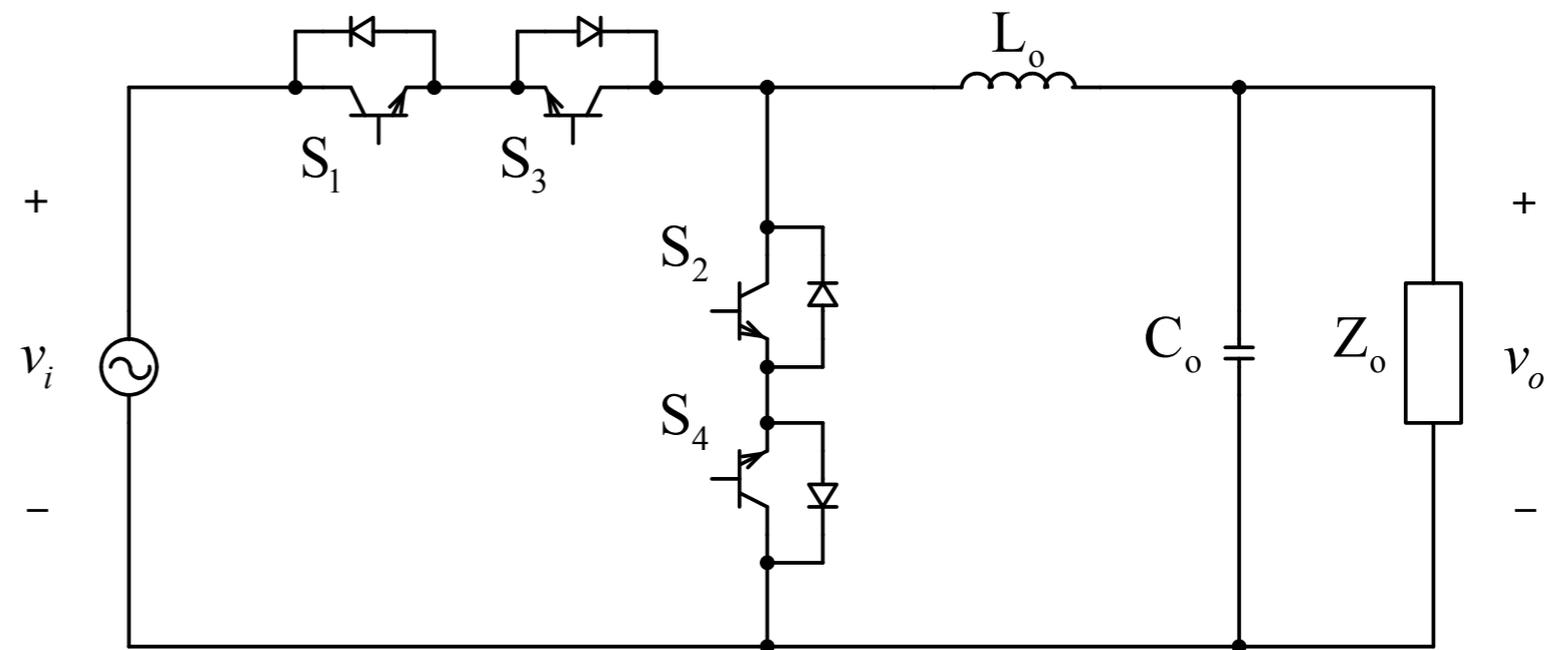


Trifásico

Conversor CA-CA: Comando



Baixa frequência



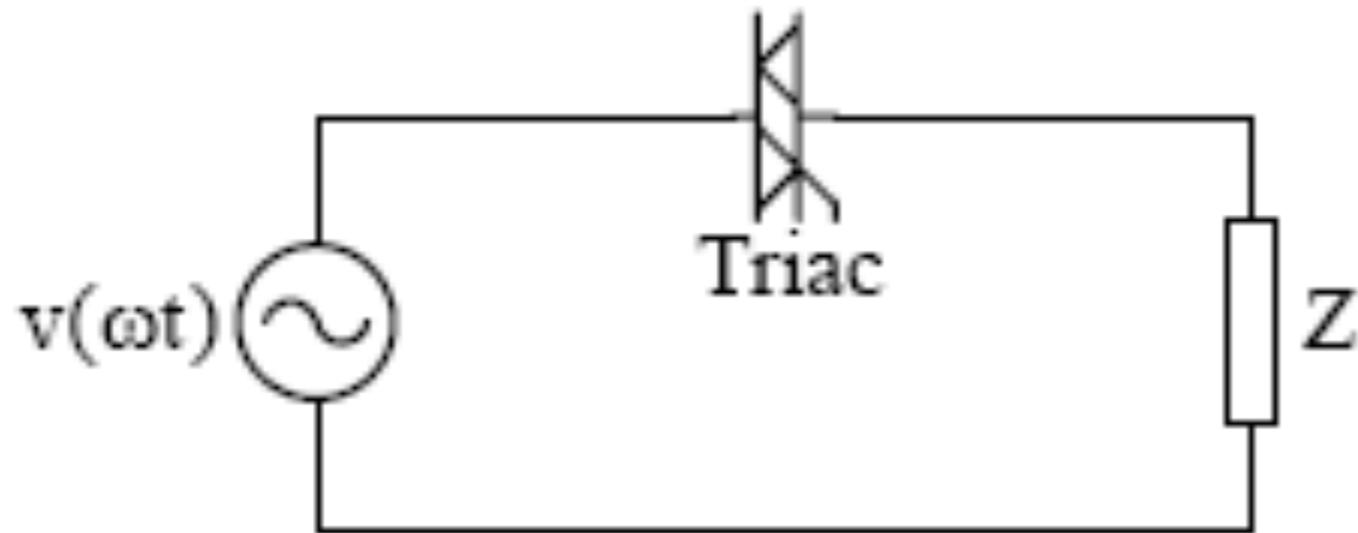
PWM alta frequência

Aplicações dos Conversores CA-CA

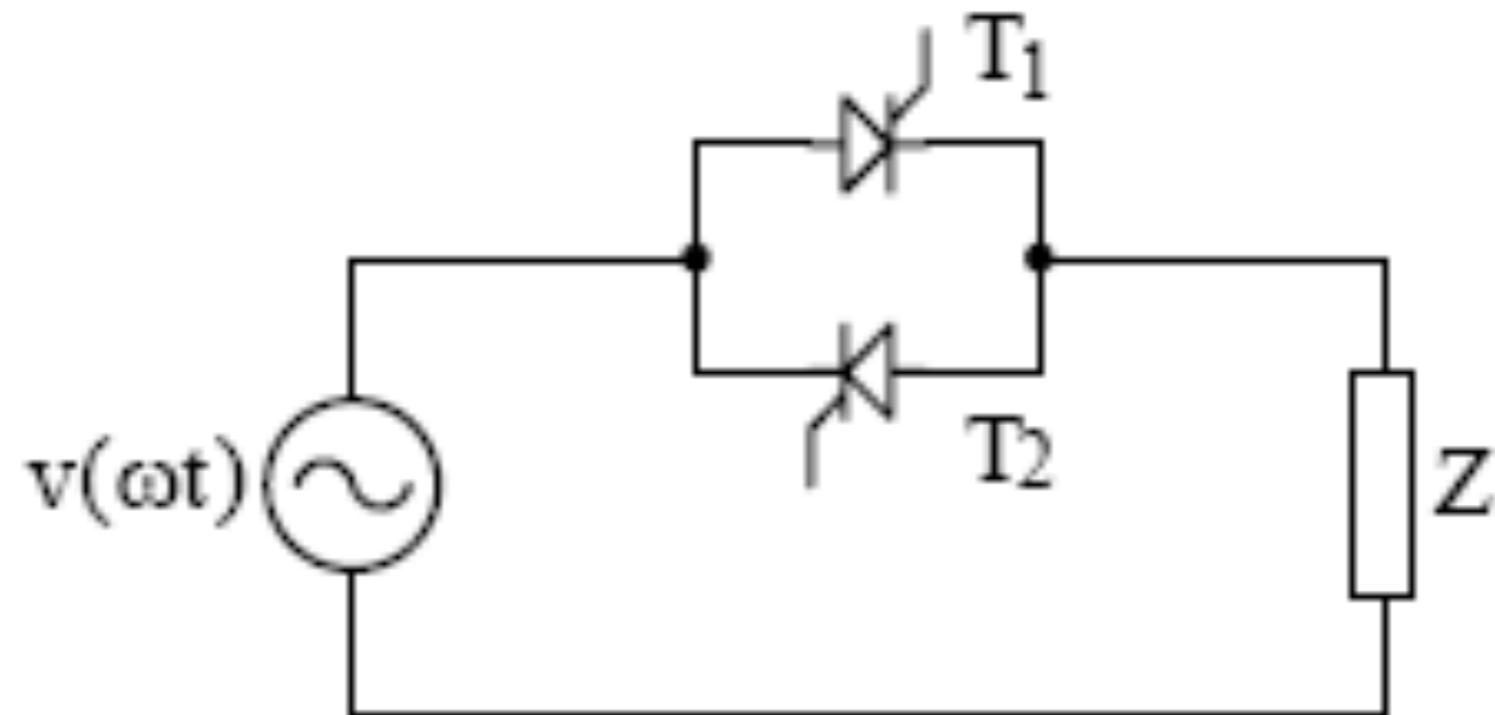
Algumas aplicações:

1. Controle de intensidade luminosa;
2. Controle de temperatura;
3. Controle de velocidade de motores de indução;
4. Limitação da corrente de partida de motores de indução;
5. Estabilizadores de tensão;
6. Filtros ativos;
7. Pré-estabilização em fontes de alimentação e UPS;
8. Economia de energia;
9. Sistemas de potência;
10. Entre outras.

Gradadores Monofásicos



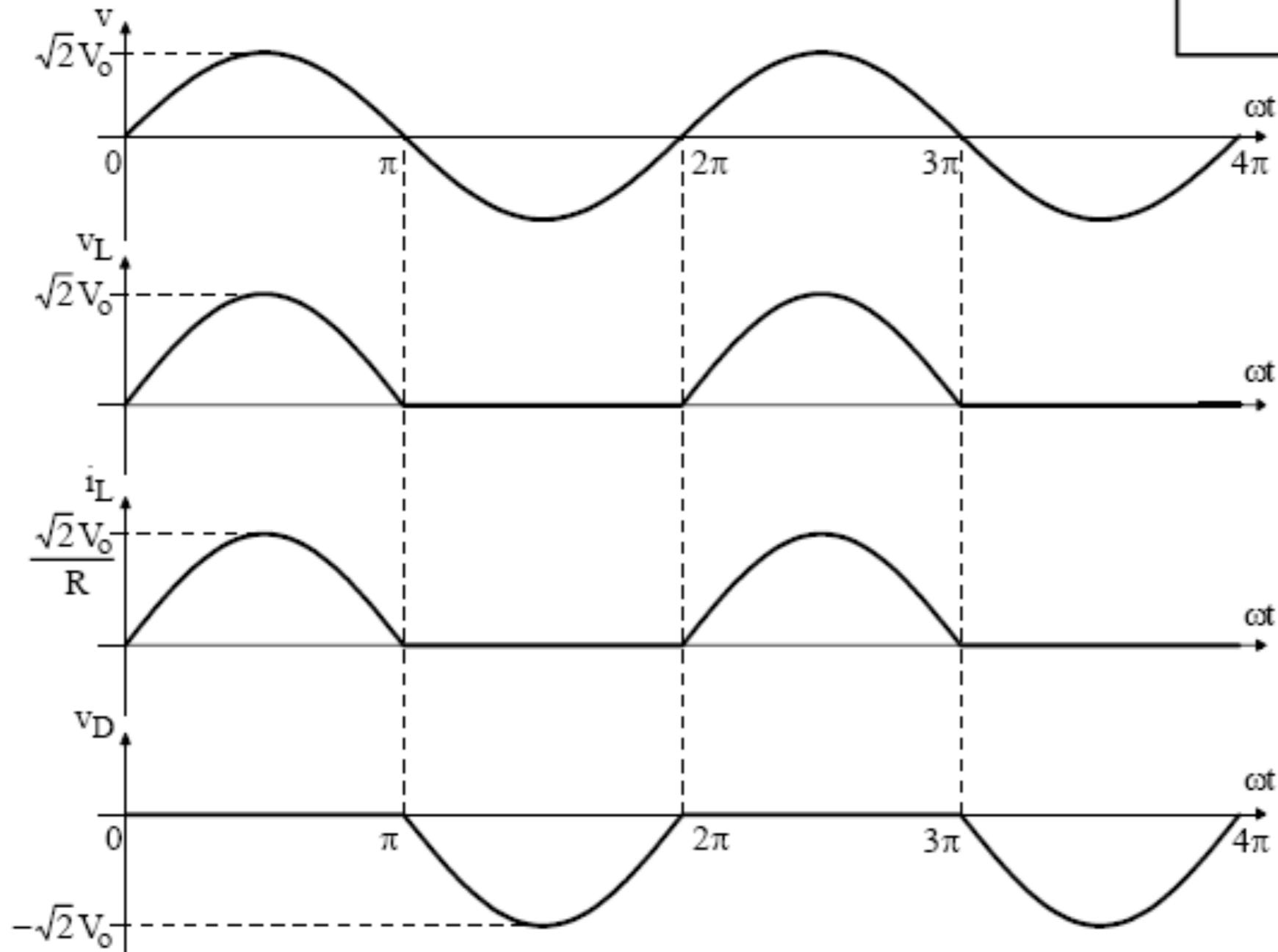
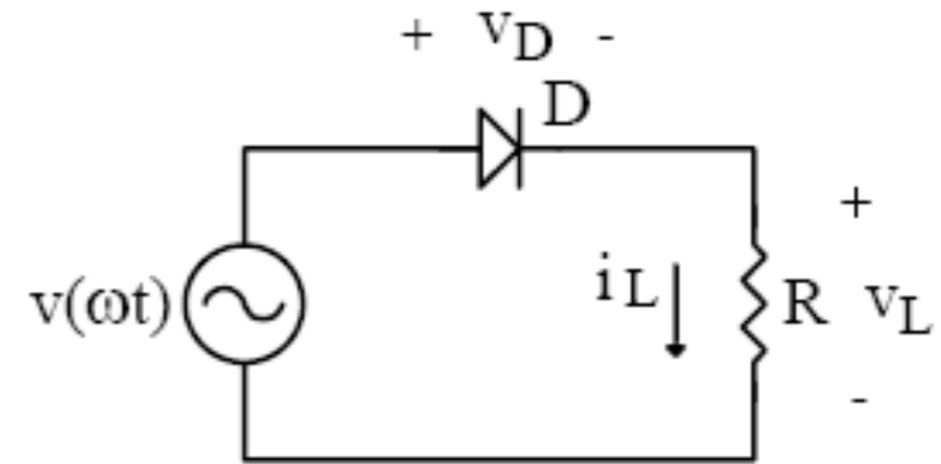
Gradador usando triac



Gradador usando tiristores

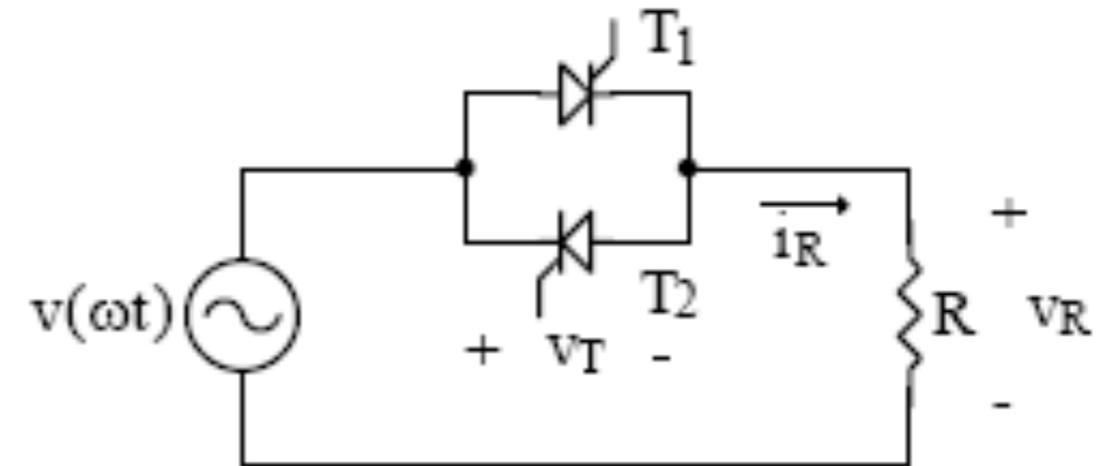
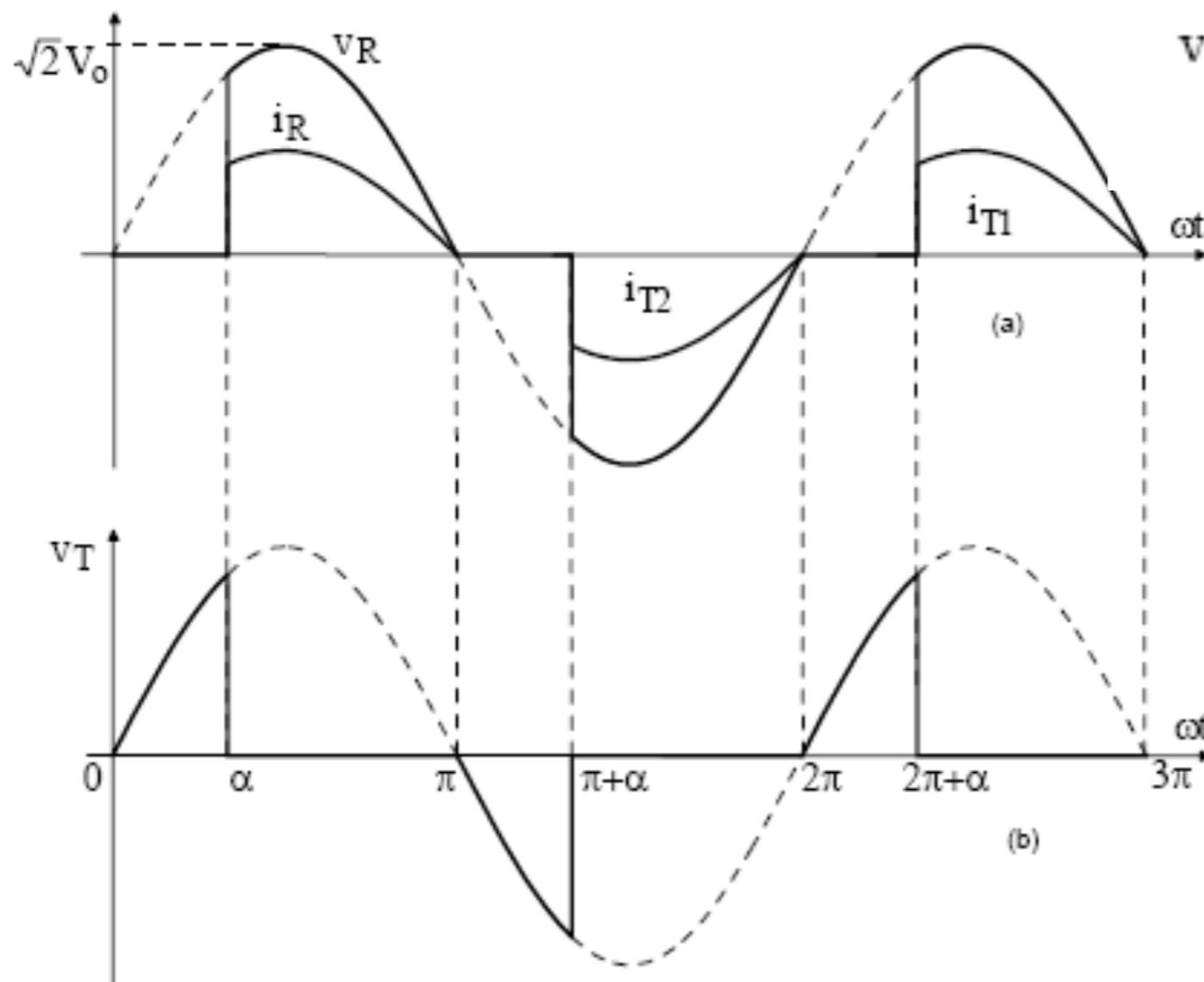
Gradadores Monofásicos

Retificador com carga resistiva pura:



Gradadores Monofásicos

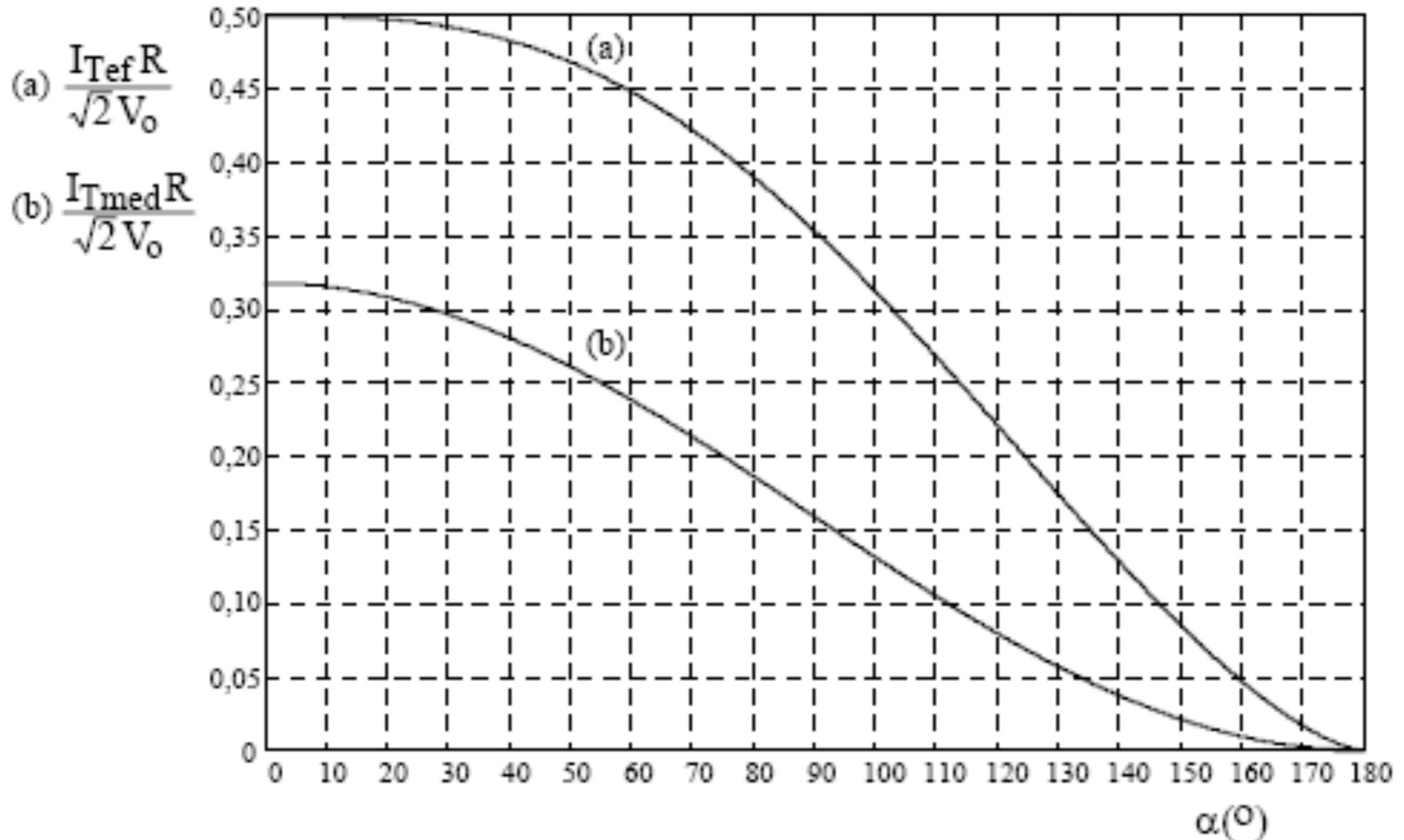
Gradador com carga resistiva pura:



$$V_o = V_i \cdot \sqrt{1 - \frac{\alpha}{\pi} + \frac{\text{sen}(2 \cdot \alpha)}{2 \cdot \pi}}$$

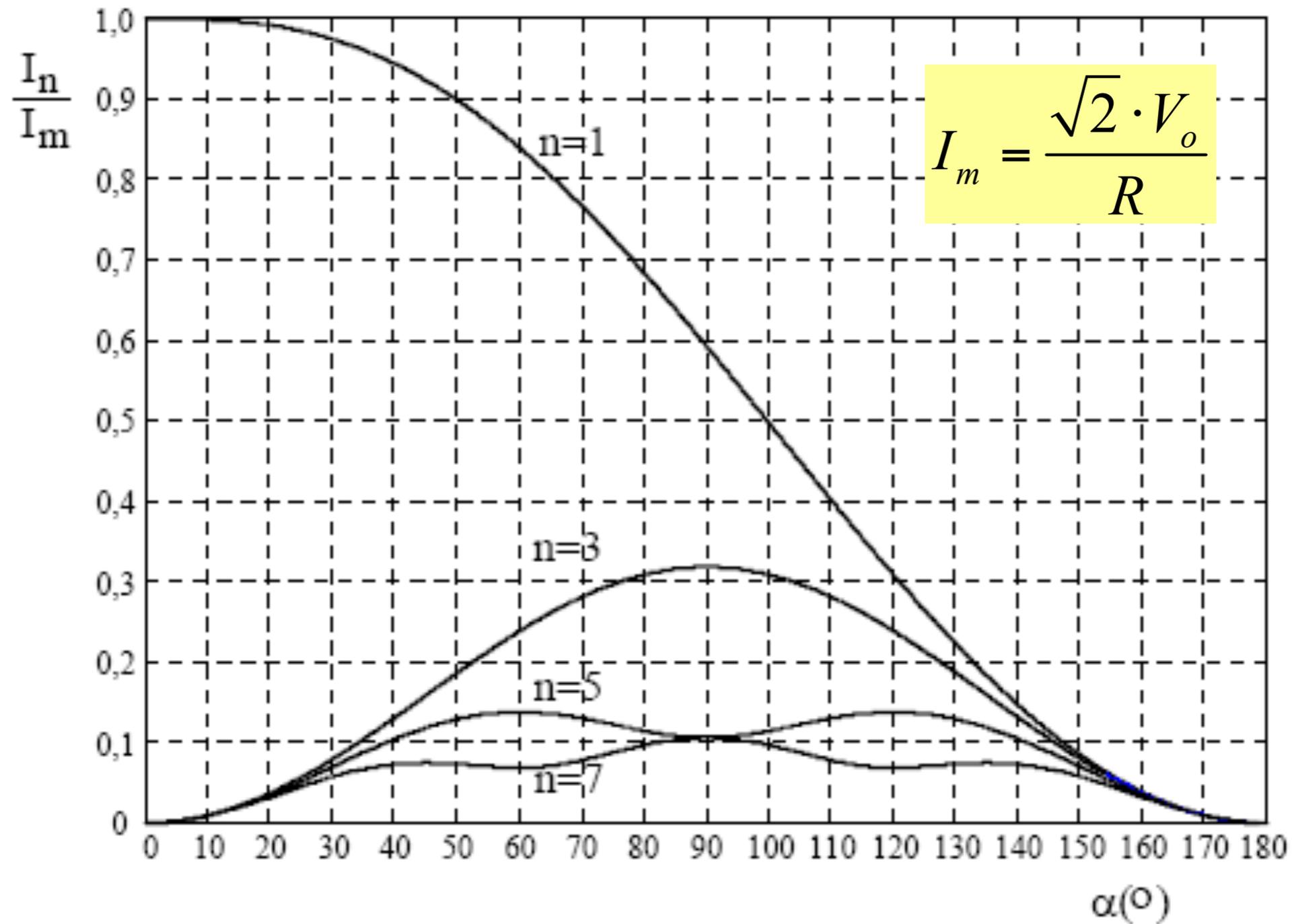
Gradadores Monofásicos

Correntes média e eficaz na carga:



Gradadores Monofásicos

Harmônicas da corrente de carga:



Gradadores Monofásicos

Harmônicas da corrente de carga, exemplo:

$$V_o = 220V$$

$$P_o = 4800W$$

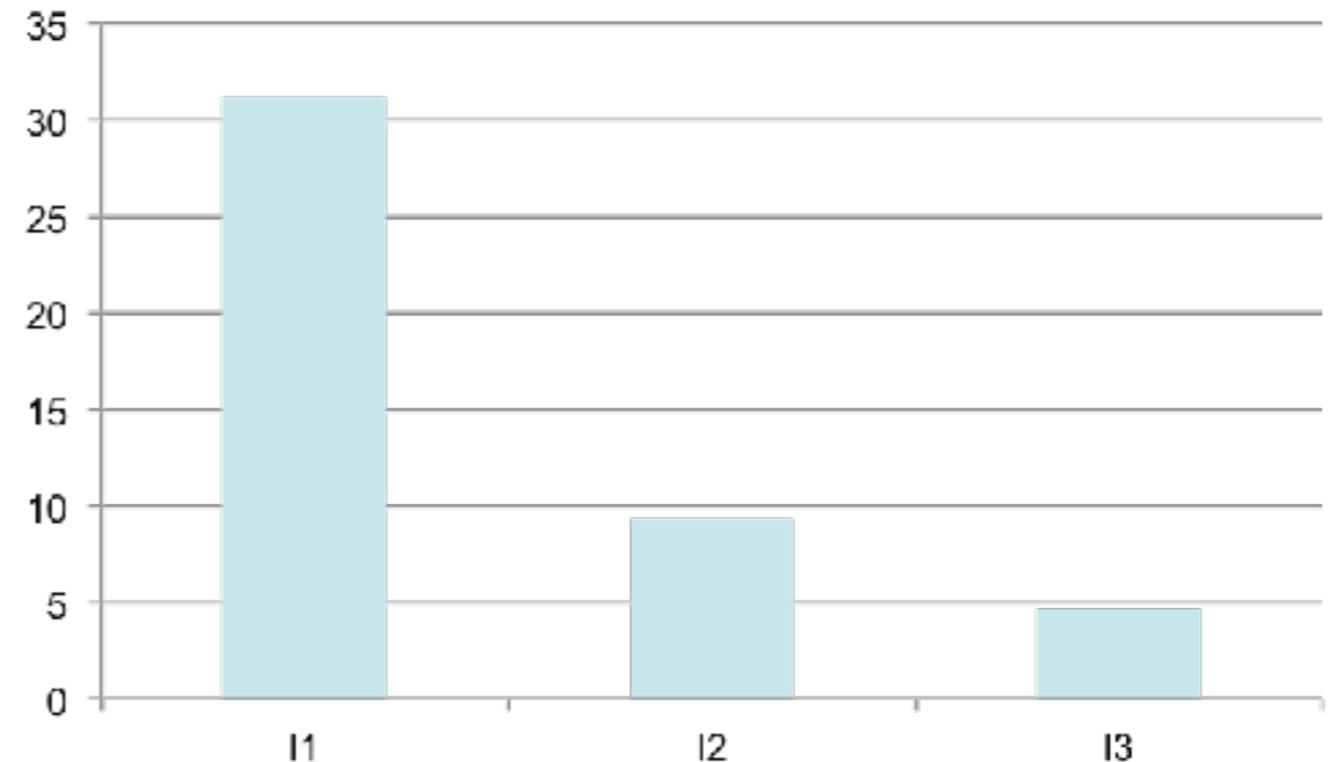
$$R = \frac{V_o^2}{P_o} = \frac{220^2}{4800} = 10\Omega$$

$$I_m = \frac{\sqrt{2} \cdot V_o}{R} = \frac{311}{10} = 31,1A$$

$$I_1 = 1 \cdot I_m = 31,1A$$

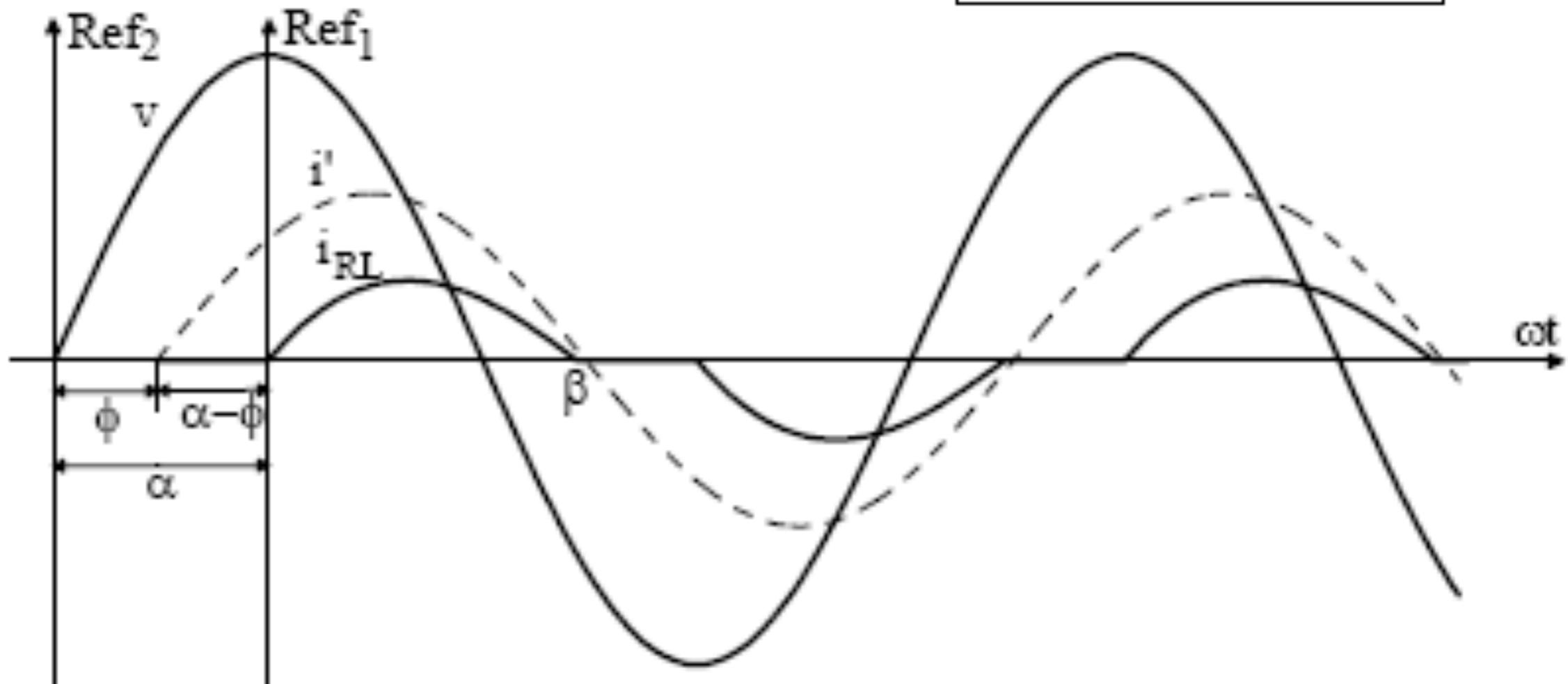
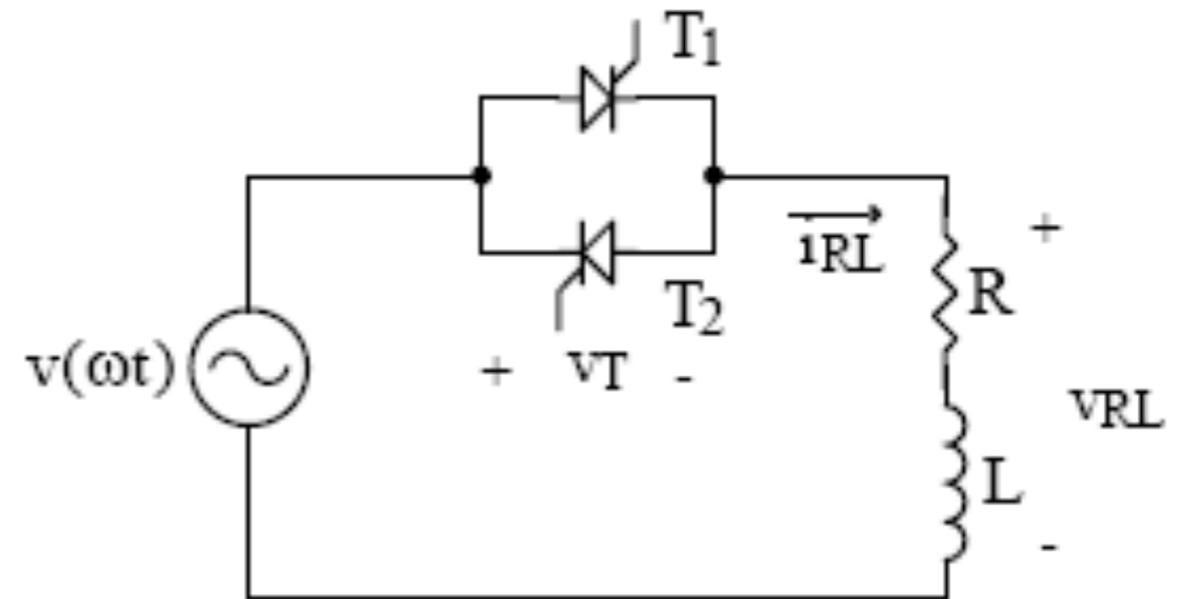
$$I_3 = 0,3 \cdot I_m = 9,33A$$

$$I_5 = 0,15 \cdot I_m = 4,66A$$



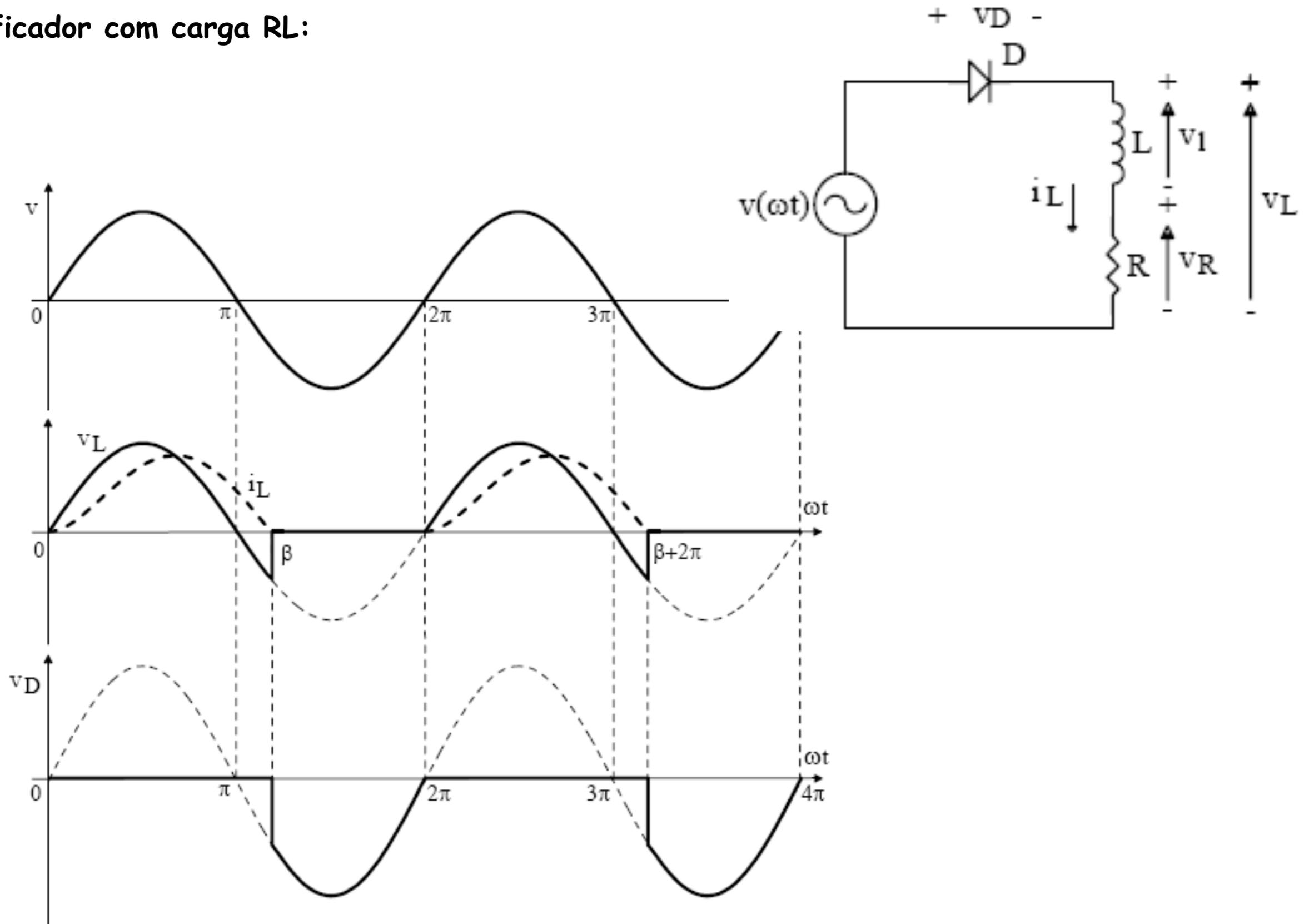
Gradadores Monofásicos

Retificador com carga RL:



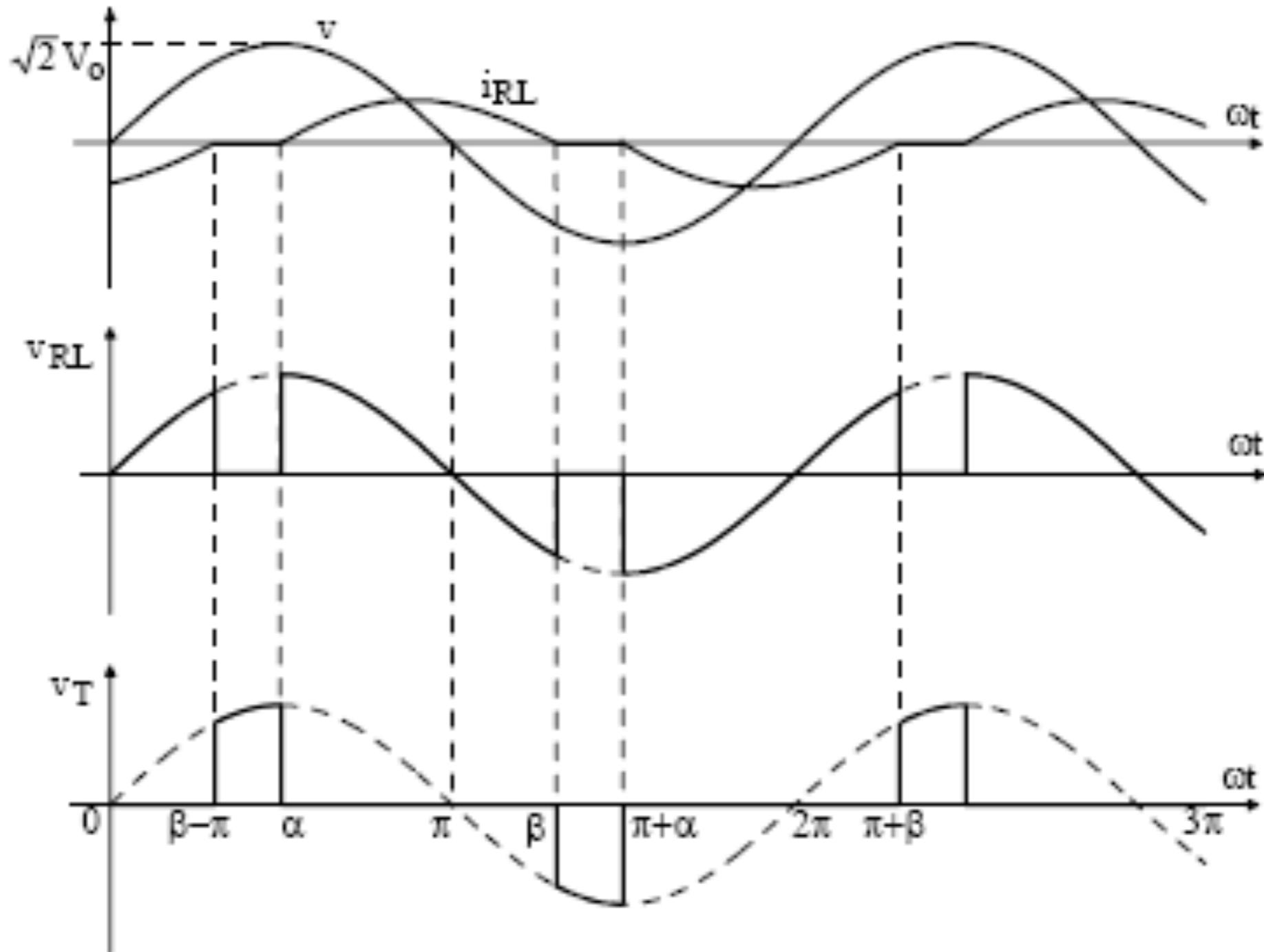
Gradadores Monofásicos

Retificador com carga RL:

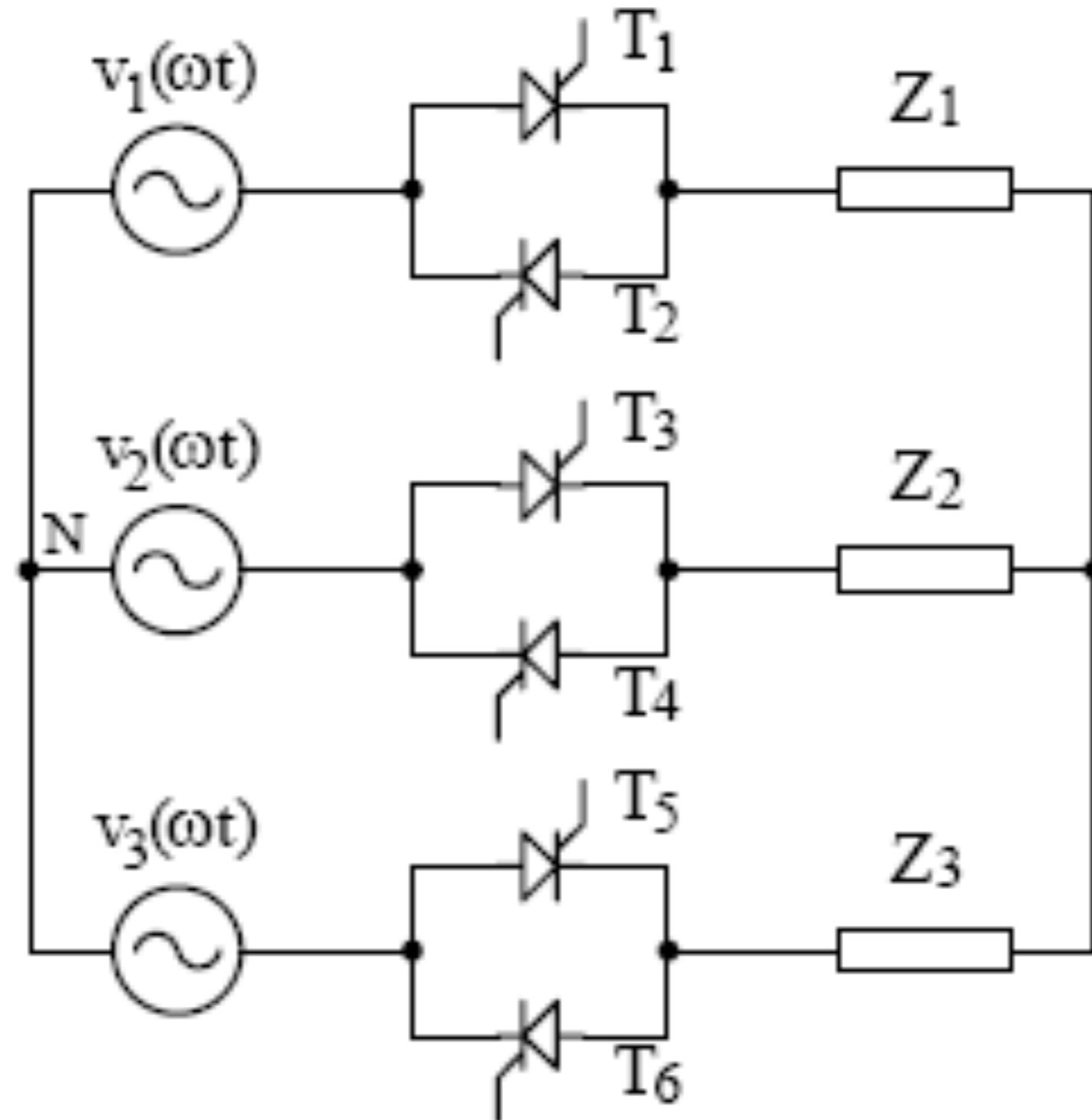


Gradadores Monofásicos

Gradador com carga RL:

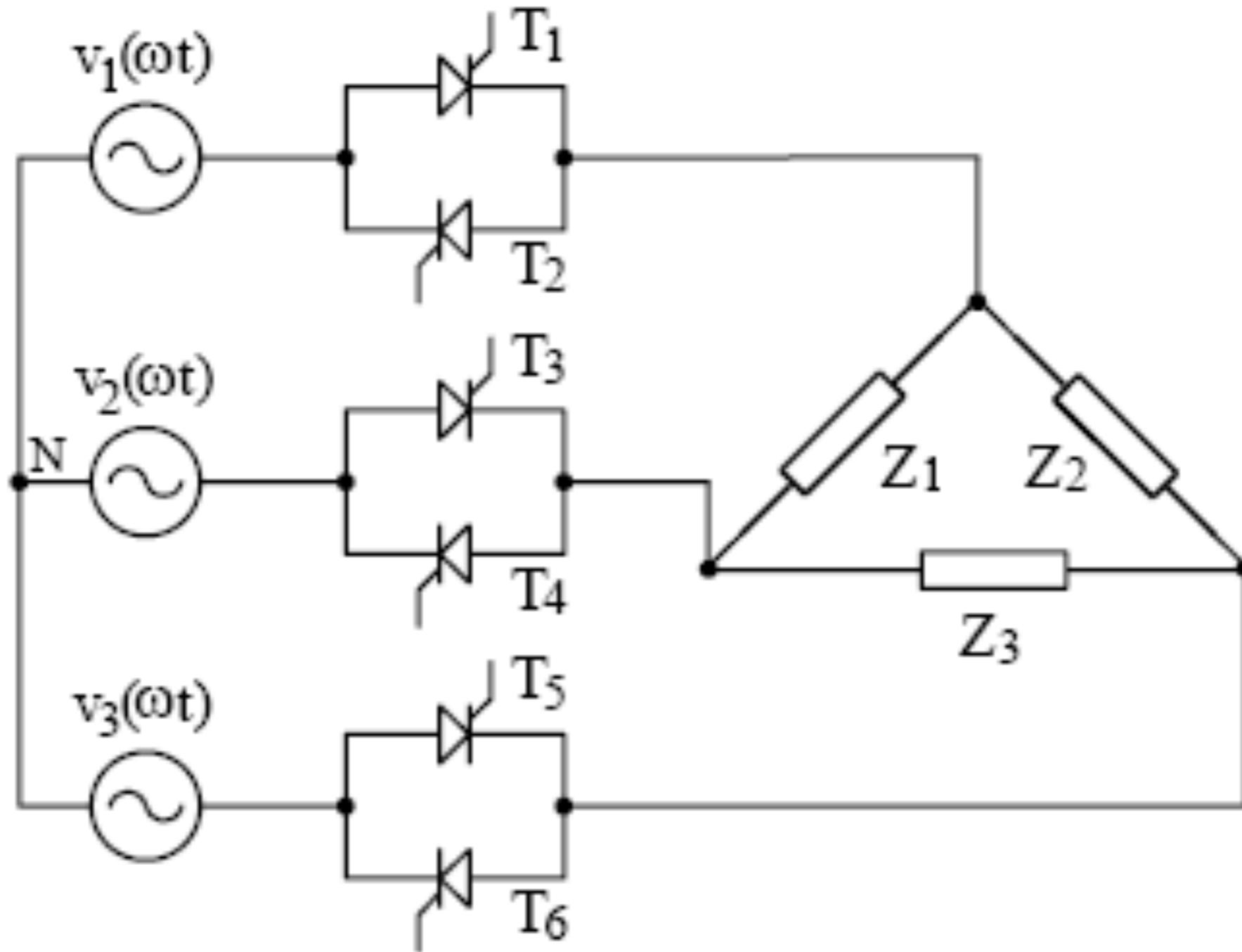


Gradadores Trifásicos



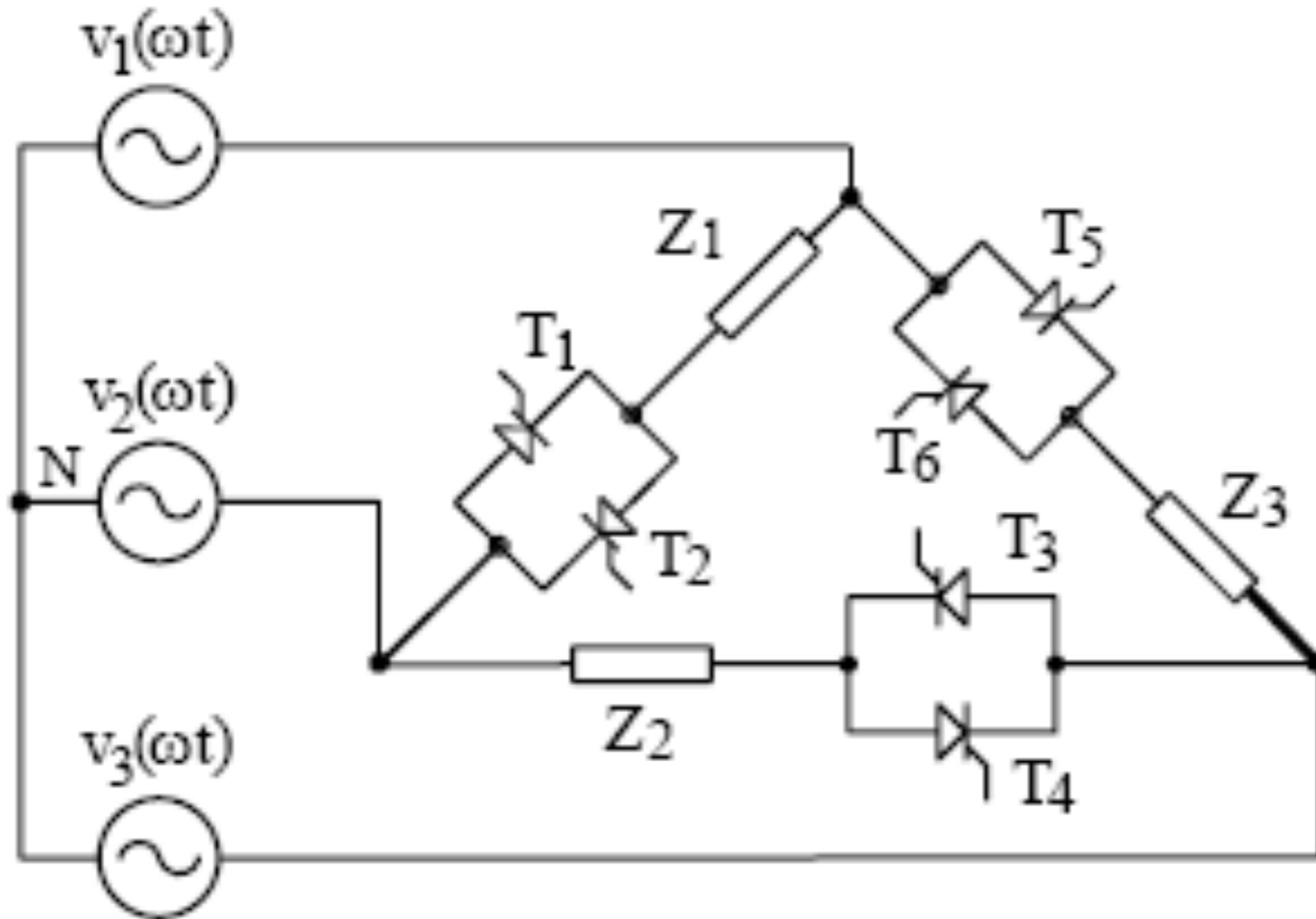
Carga conectada em estrela (Y)

Gradadores Trifásicos



Carga conectada em delta (Δ)

Gradadores Trifásicos



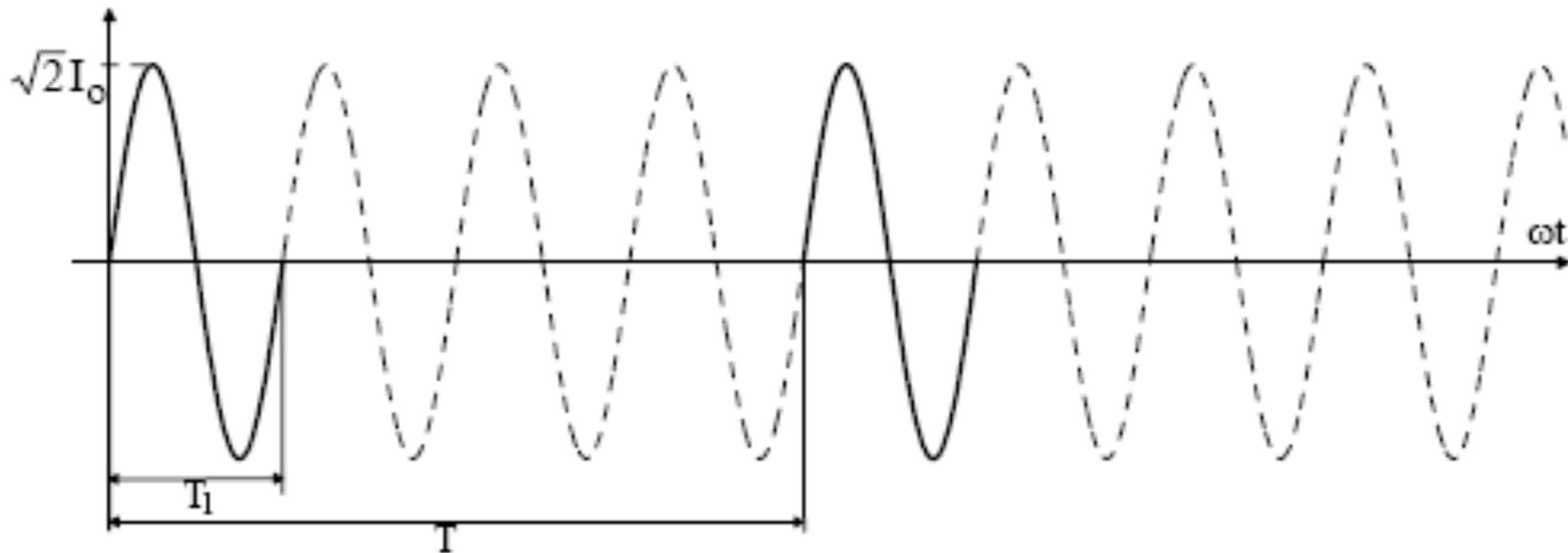
Carga conectada em delta (Δ)

Controle por Ciclos Inteiros

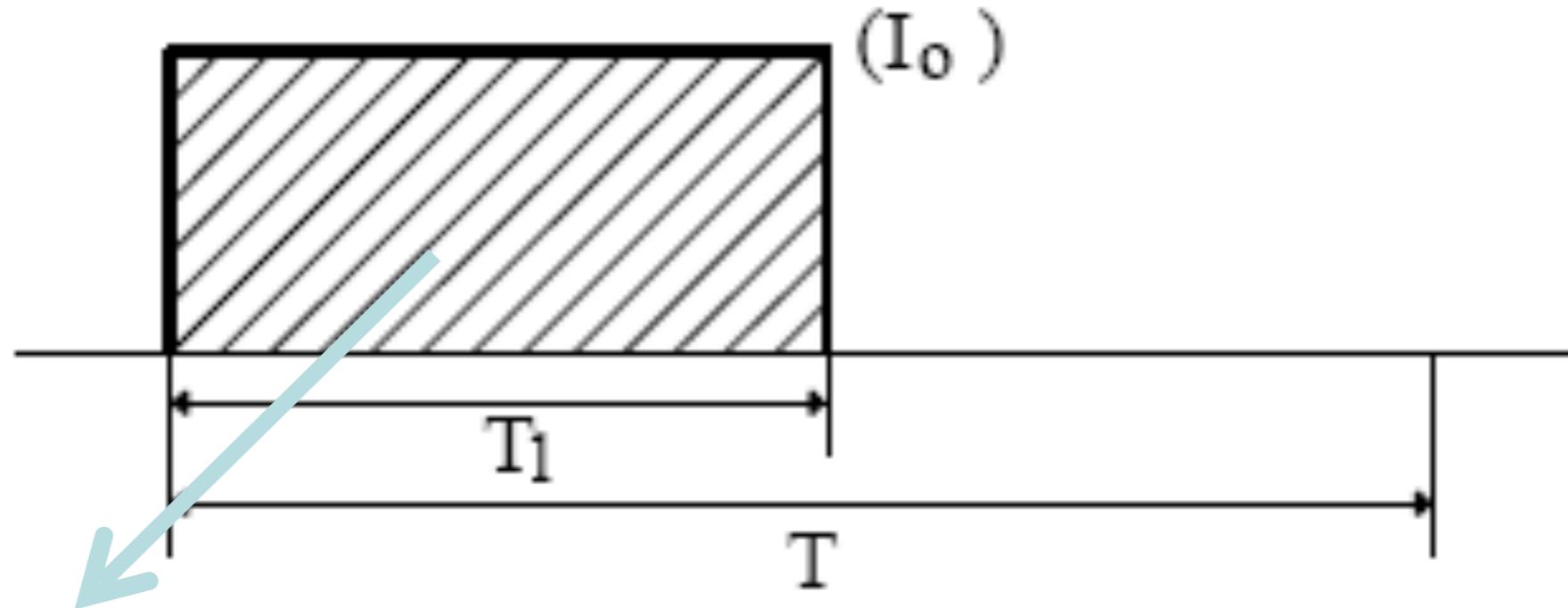
Deficiências dos gradadores:

1. Introduzem harmônicas significativas de corrente na rede;
2. Para ângulos de disparo (α) elevados o fator de potência é baixo.

Controle por ciclos inteiros:



Controle por Ciclos Inteiros



$$W_1 = R \cdot I_o^2 \cdot T_1$$

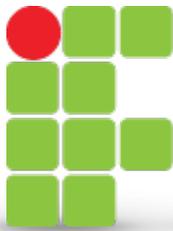
$$W_2 = R \cdot I^2 \cdot T$$

m = número de ciclos aplicados à carga;
 M = número de ciclos da rede.

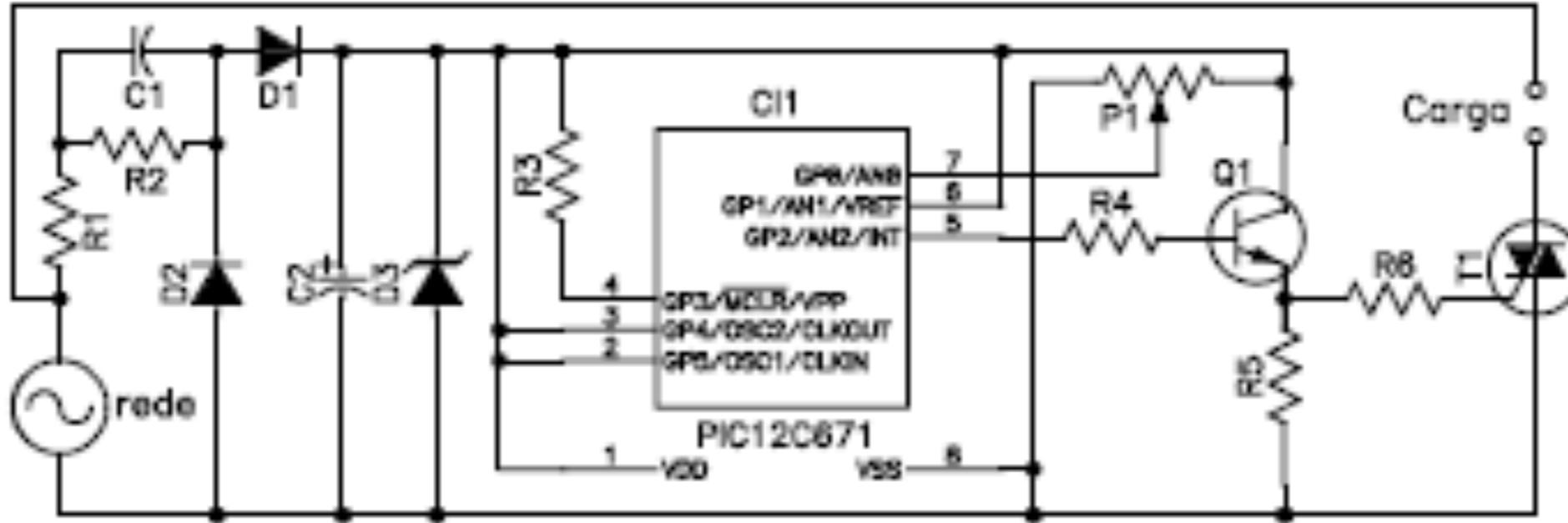
$$W_1 = W_2$$

$$R \cdot I_o^2 \cdot T_1 = R \cdot I^2 \cdot T$$

$$I = \sqrt{\frac{T_1}{T}} \cdot I_o = \sqrt{\frac{m}{M}} \cdot I_o$$



Controle por Ciclos Inteiros



A New Technique for Simple Control of AC Loads Using AC-DC Converter

Problema de controle de potência, de tensão e amplitude de onda

Objetivo: Este trabalho apresenta uma nova técnica de controle de potência, de tensão e amplitude de onda de uma carga AC, utilizando um conversor AC-DC, um controlador digital e um inversor AC-DC.

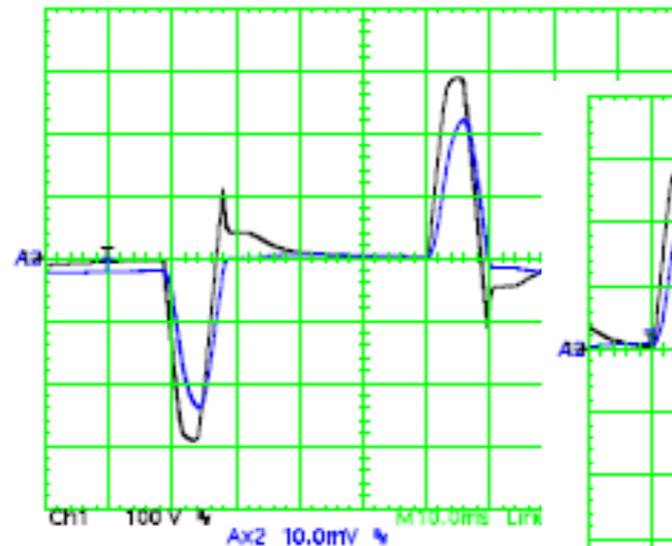
Introdução: Este trabalho apresenta uma nova técnica de controle de potência, de tensão e amplitude de onda de uma carga AC, utilizando um conversor AC-DC, um controlador digital e um inversor AC-DC.

2. CONTROLANDO CICLOS INTEIROS

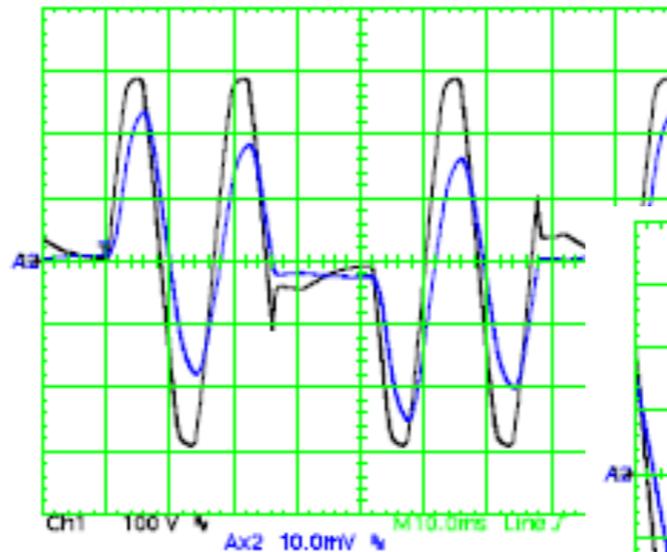
2.1. Princípio de funcionamento

Fig. 1. Diagrama de blocos do sistema de controle por ciclos inteiros.

Fig. 2. Diagrama de blocos do sistema de controle por ciclos inteiros.

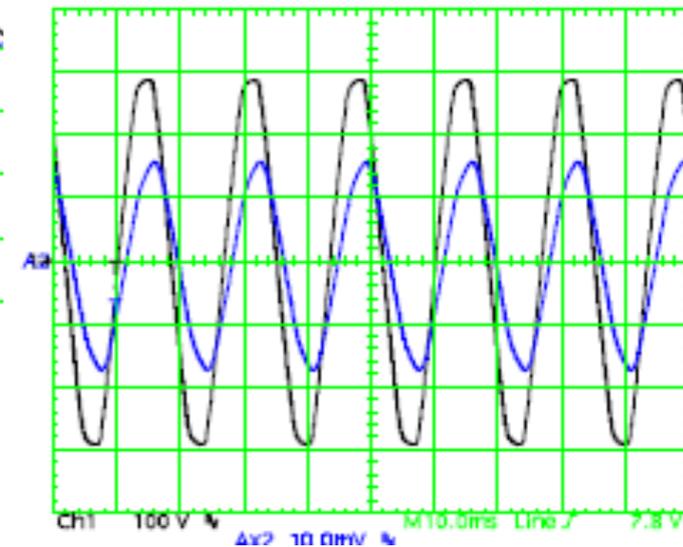


$$\frac{m}{M} = \frac{1}{5}$$

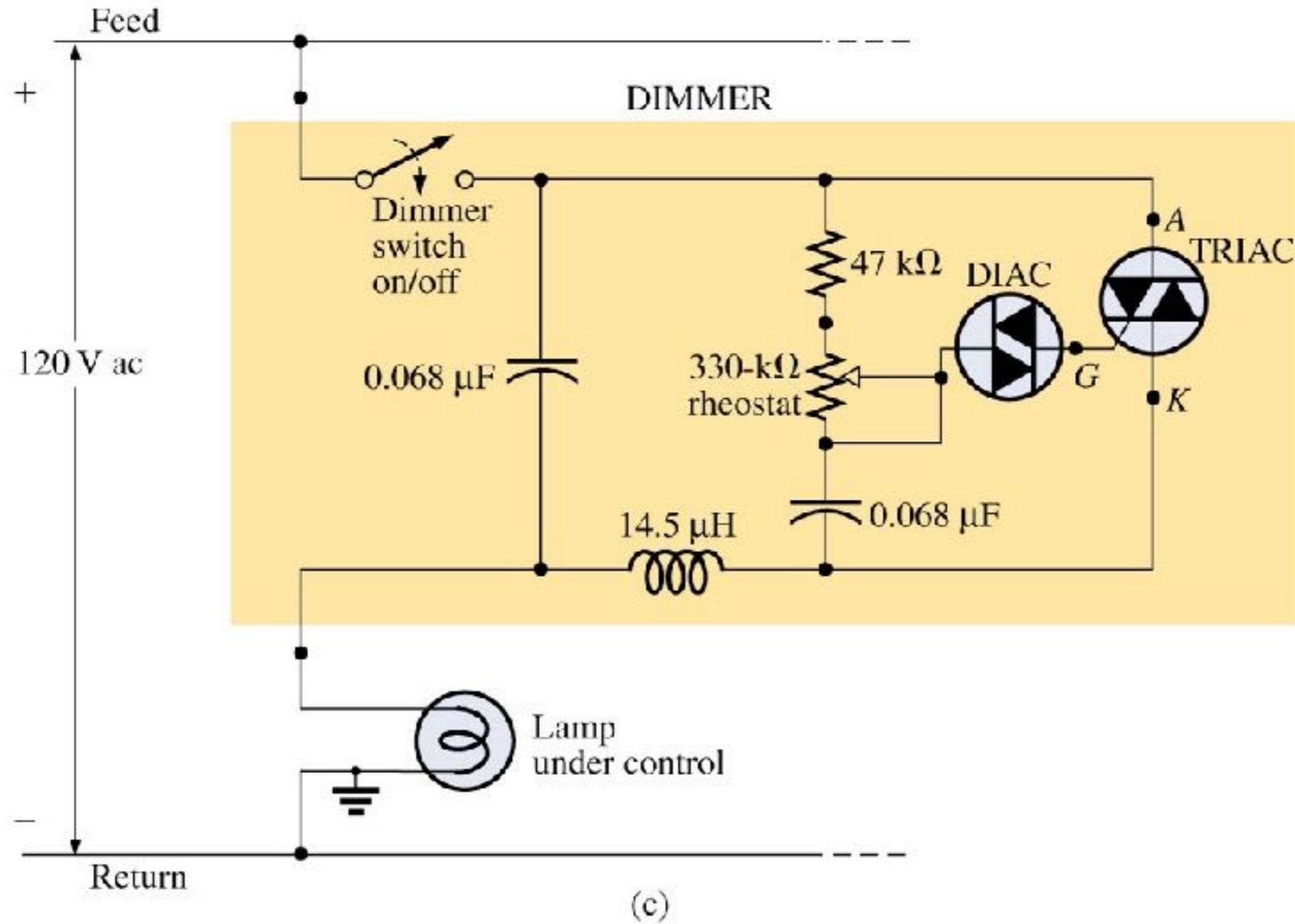


$$\frac{m}{M} = \frac{3}{5}$$

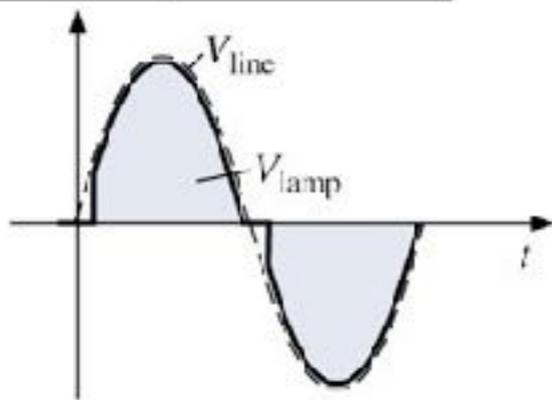
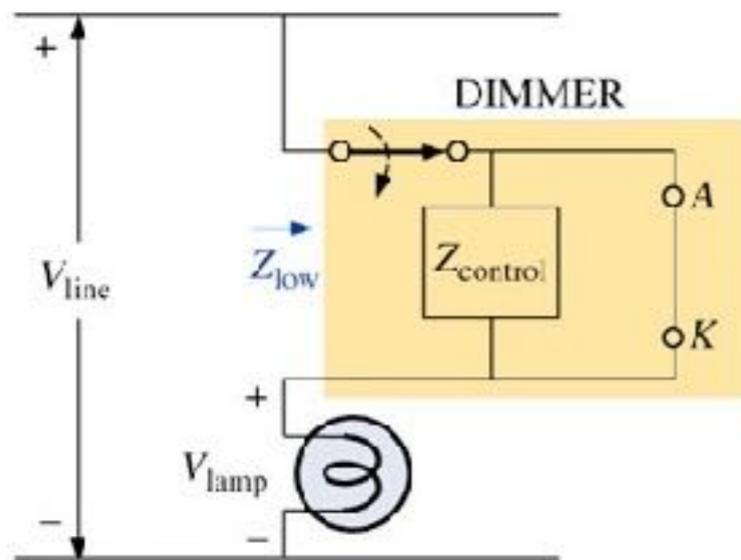
$$\frac{m}{M} = \frac{5}{5}$$



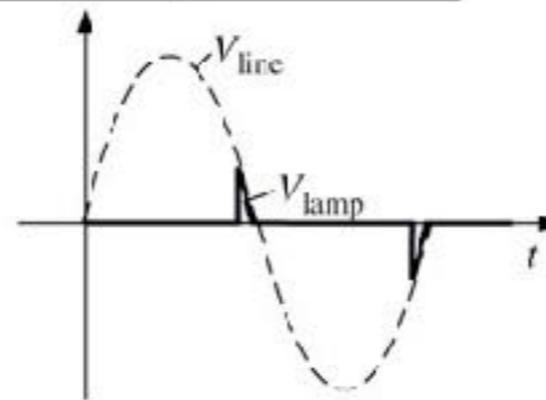
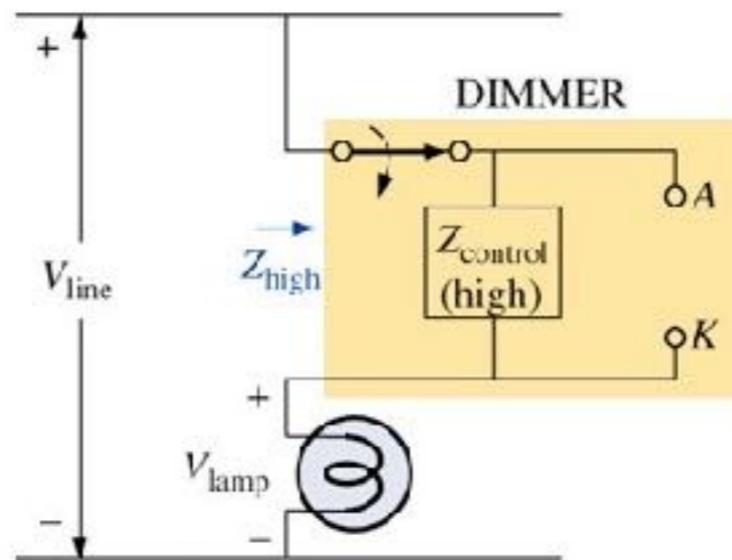
Implementação do gradador monofásico (dimmer)



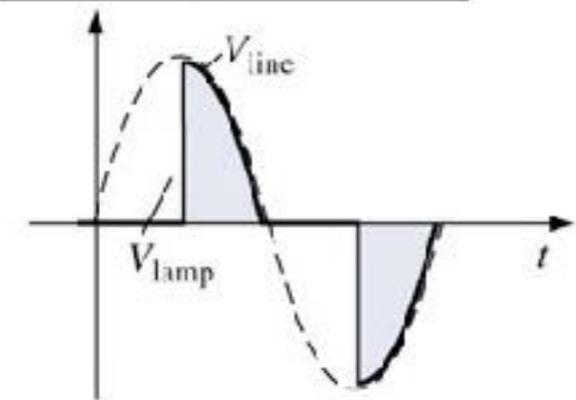
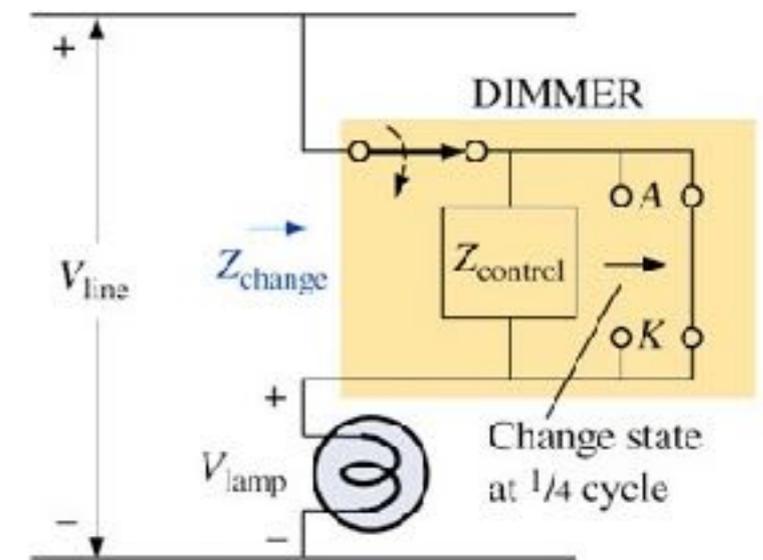
Implementação do gradador monofásico (dimmer)



(a)

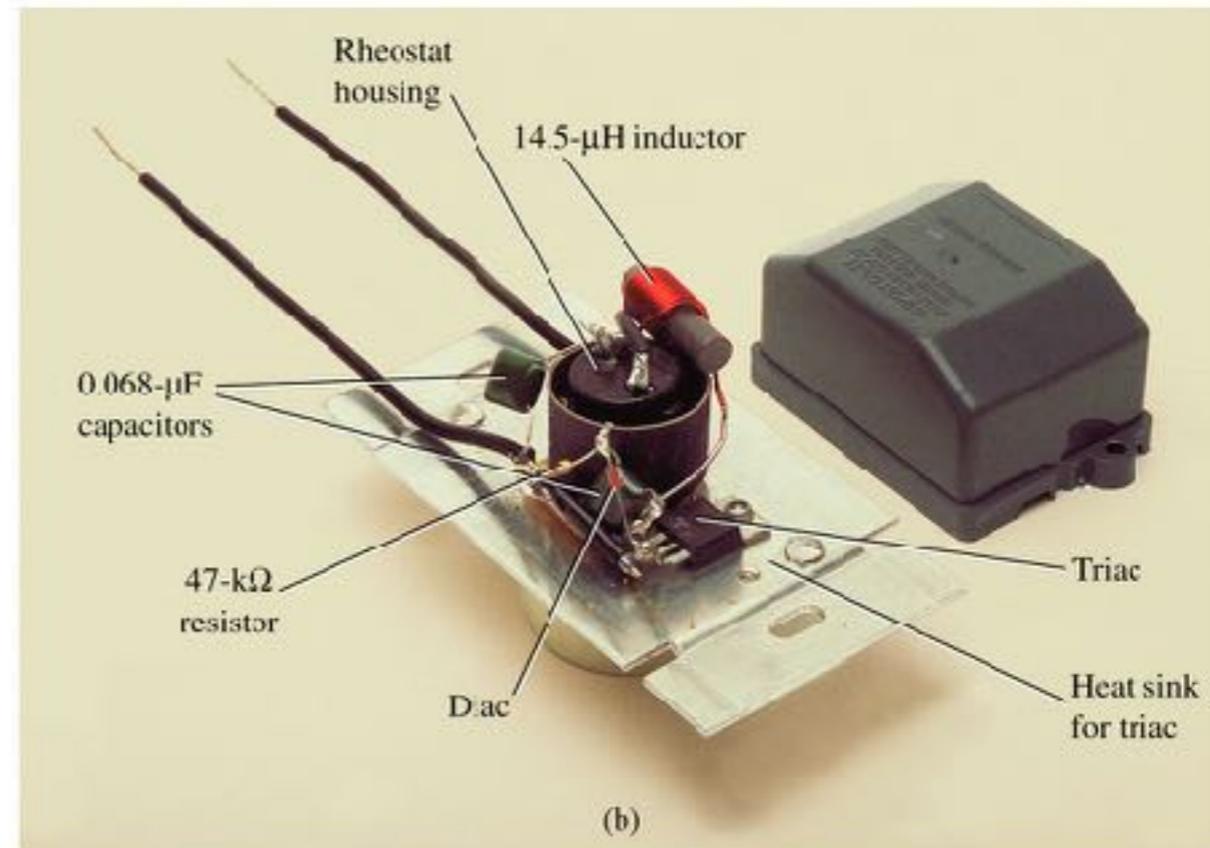


(b)



(c)

Implementação do gradador monofásico (dimmer)

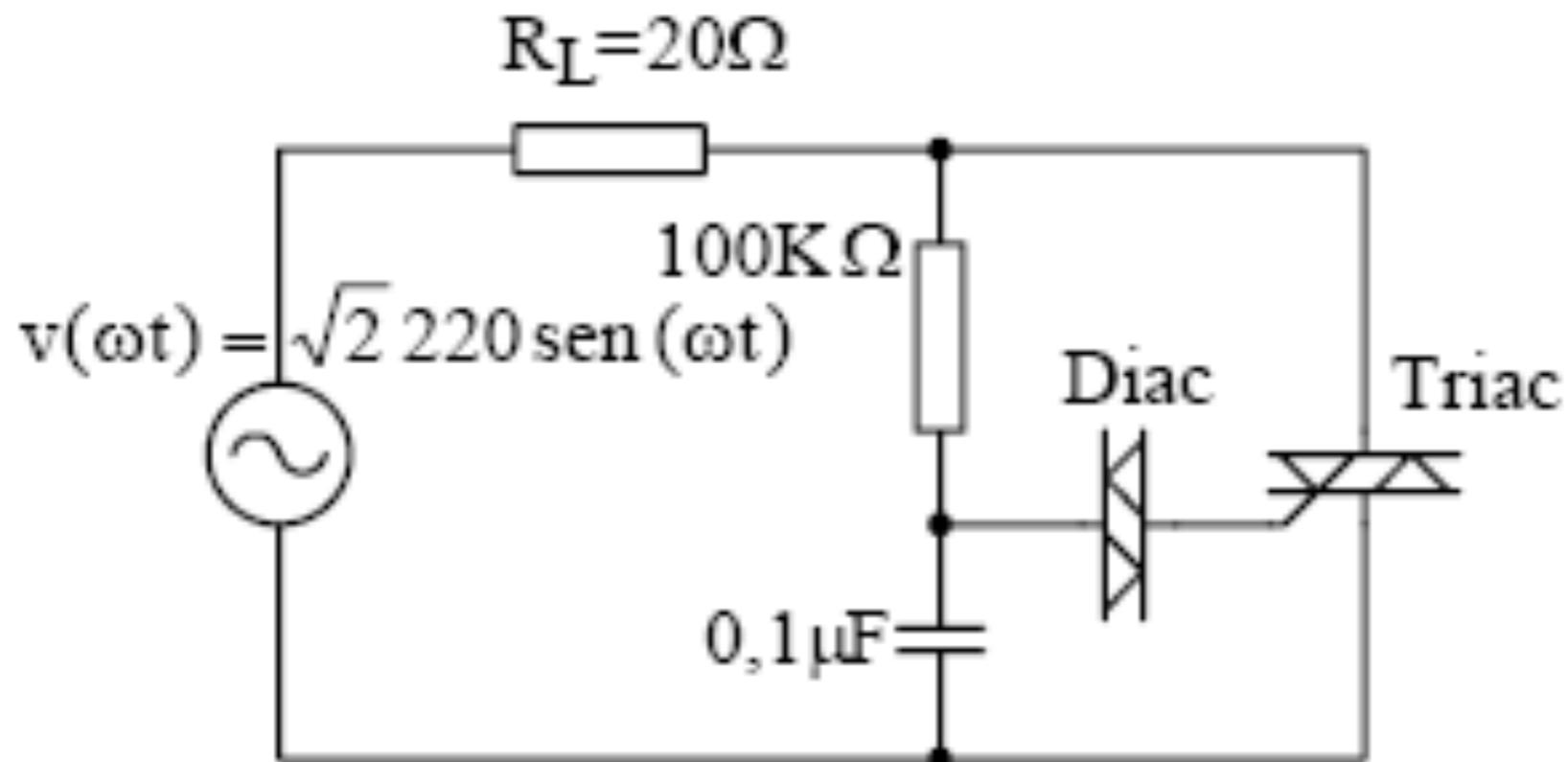


Implementação do gradador monofásico (dimmer)

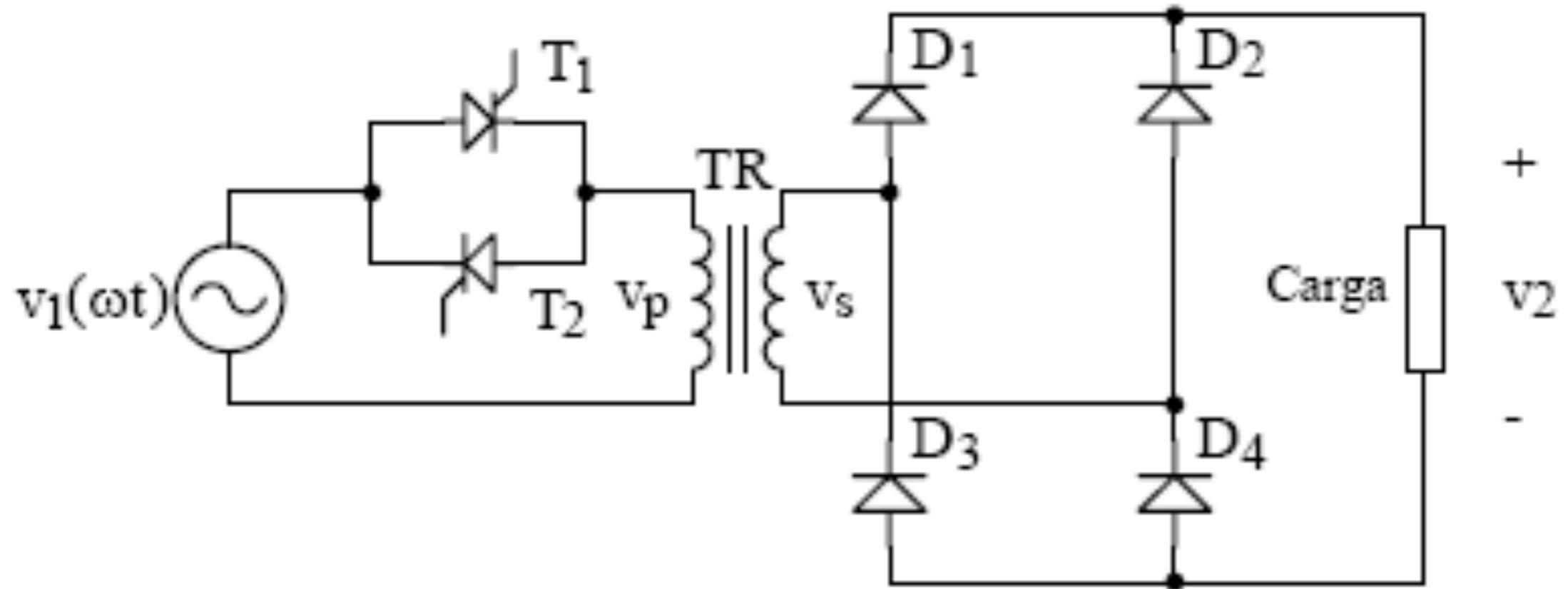
Tarefa:

Estudar o exercício 6, do
Capítulo 7 - Gradadores.

Diac de ± 42 V.



Partida de Cargas com Gradadores



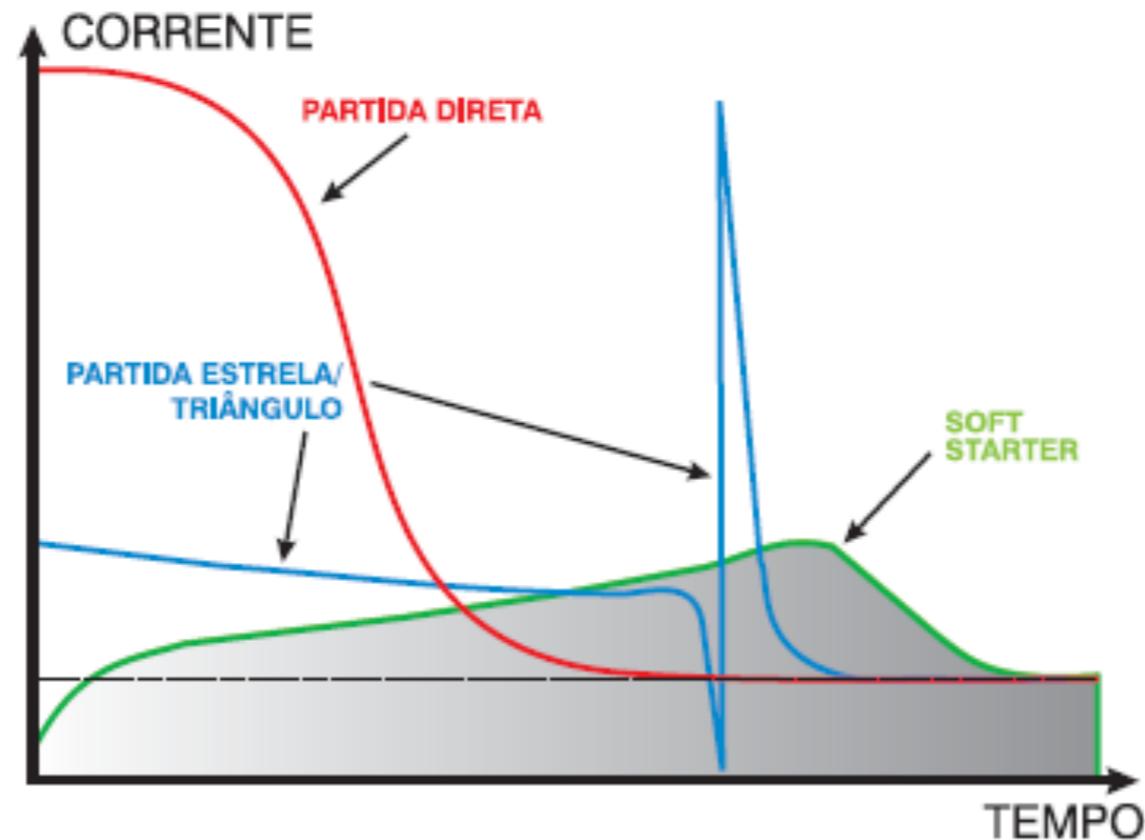
Controle da tensão de saída do retificador pelo gradador

Partida de Cargas com Gradadores



SSW 05
SOFT-STARTER *Plus*

- Potência : 0,75 a 75cv
- Tensão : 220 a 575 V
- By-pass incorporado
- Controle com DSP
- HMI remota (opcional)
- Proteções do motor incorporadas
- Operação em ambientes de até 55°



www.weg.com.br

Controle da corrente de partida de motores usando gradadores

Disparo dos Tiristores

MKP1V120 Series

Preferred Device

Sidac High Voltage

Bidirectional Triggers

Bidirectional devices designed for direct interface with the ac power line. Upon reaching the breakover voltage in each direction, the device switches from a blocking state to a low voltage on-state. Conduction will continue like a Triac until the main terminal current drops below the holding current. The plastic axial lead package provides high pulse current capability at low cost. Glass passivation insures reliable operation.

Features

- High Pressure Sodium Vapor Lighting
- Strobes and Flashers
- Igniters
- High Voltage Regulators
- Pulse Generators
- Used to Trigger Gates of SCR's and Triacs
- Pb Indicates UL Registered — File #E116110
- These are Pb-Free Devices*

MAXIMUM RATINGS ($T_J = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Peak Repetitive Off-State Voltage (Sine Wave, 50 to 60 Hz, $T_J = -40$ to 125°C) MKP1V120, MKP1V130, MKP1V180 MKP1V240	V_{DRM} V _{DRM}	± 90 ± 180	V
On-State Current RMS ($T_J = 80^\circ\text{C}$, Lead Length = 3/8", All Conduction Angles)	I_{TRMS}	± 0.9	A
Peak Non-repetitive Surge Current (80 Hz One Cycle Sine Wave, $T_J = 125^\circ\text{C}$)	I_{TSM}	± 4.0	A
Operating Junction Temperature Range	T_J	-40 to $+125$	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-40 to $+150$	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Lead Lead Length = 3/8"	$R_{\theta JL}$	40	$^\circ\text{C/W}$
Lead Solder Temperature (Lead Length $\geq 1/16"$ from Case, 10 s Max)	T_L	260	$^\circ\text{C}$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

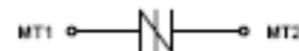
*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



ON Semiconductor®

<http://onsemi.com>

SIDACS(93)
0.9 AMPERES RMS
120 - 240 VOLTS



AXIAL LEAD
CASE 58
STYLE 2

MARKING DIAGRAM

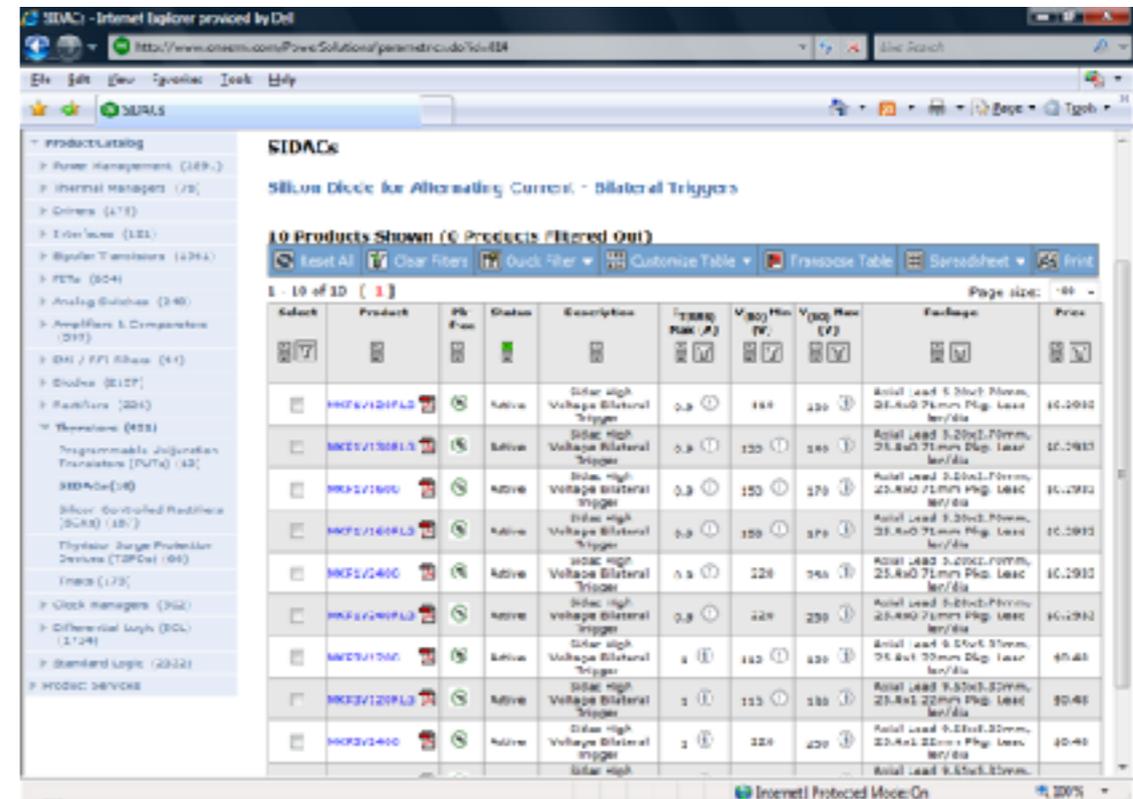


A = Assembly Location
MKP1Vxxx0 = Device Number
xx = 12, 13, 15 or 24
YY = Year
WW = Work Week
• = Pb-Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

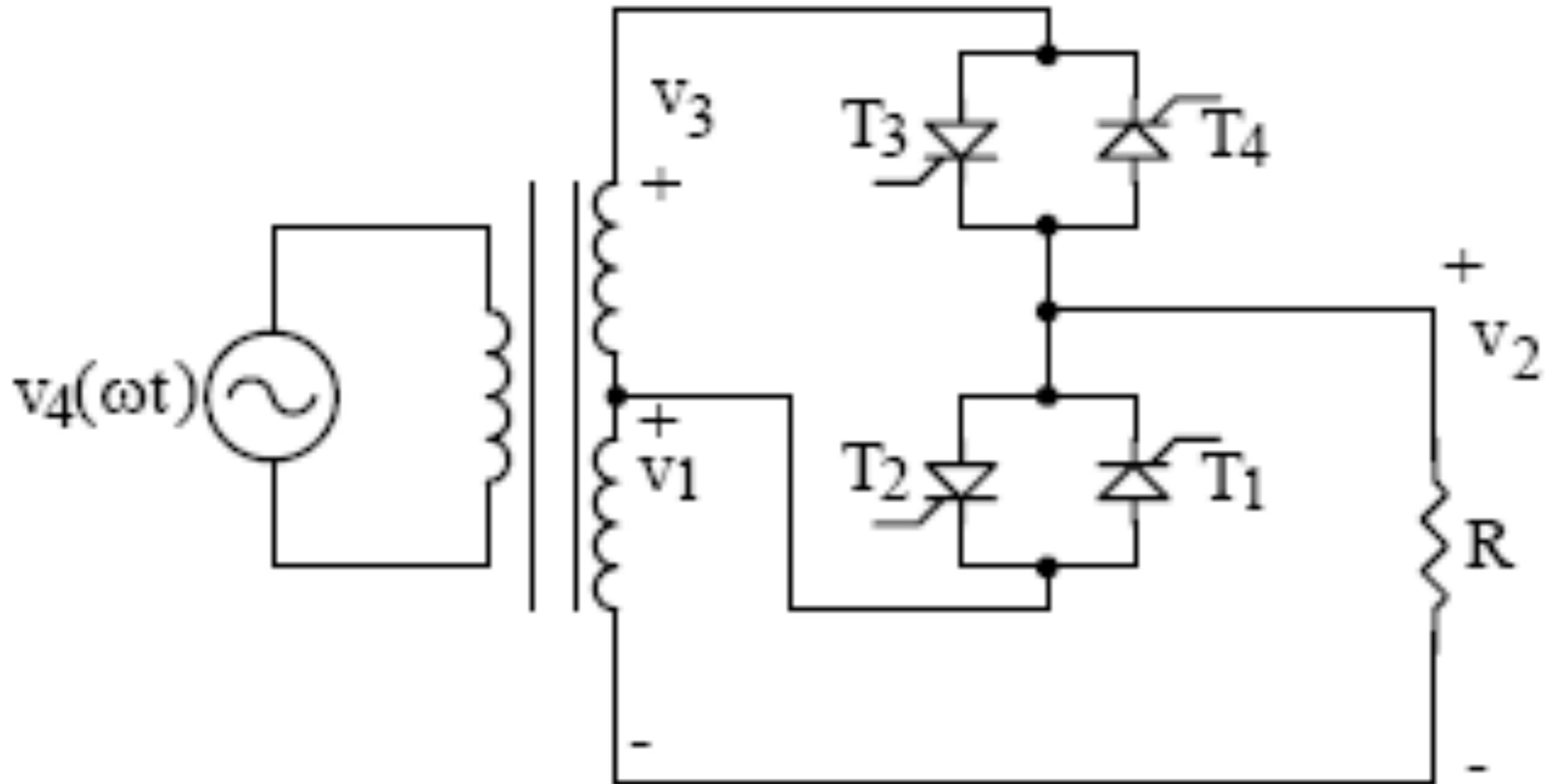
Preferred devices are recommended choices for future use and best overall value.



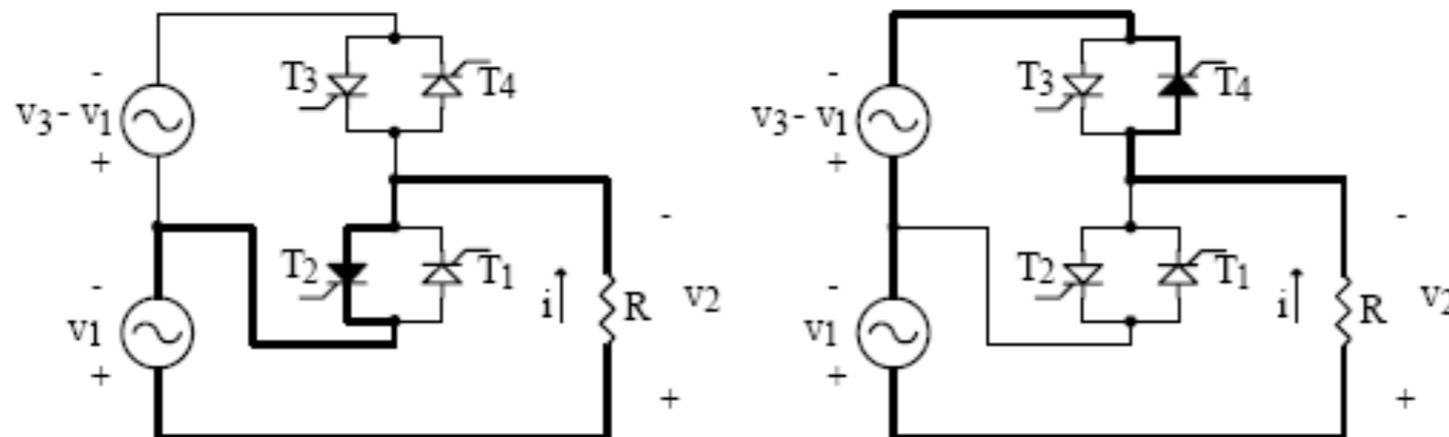
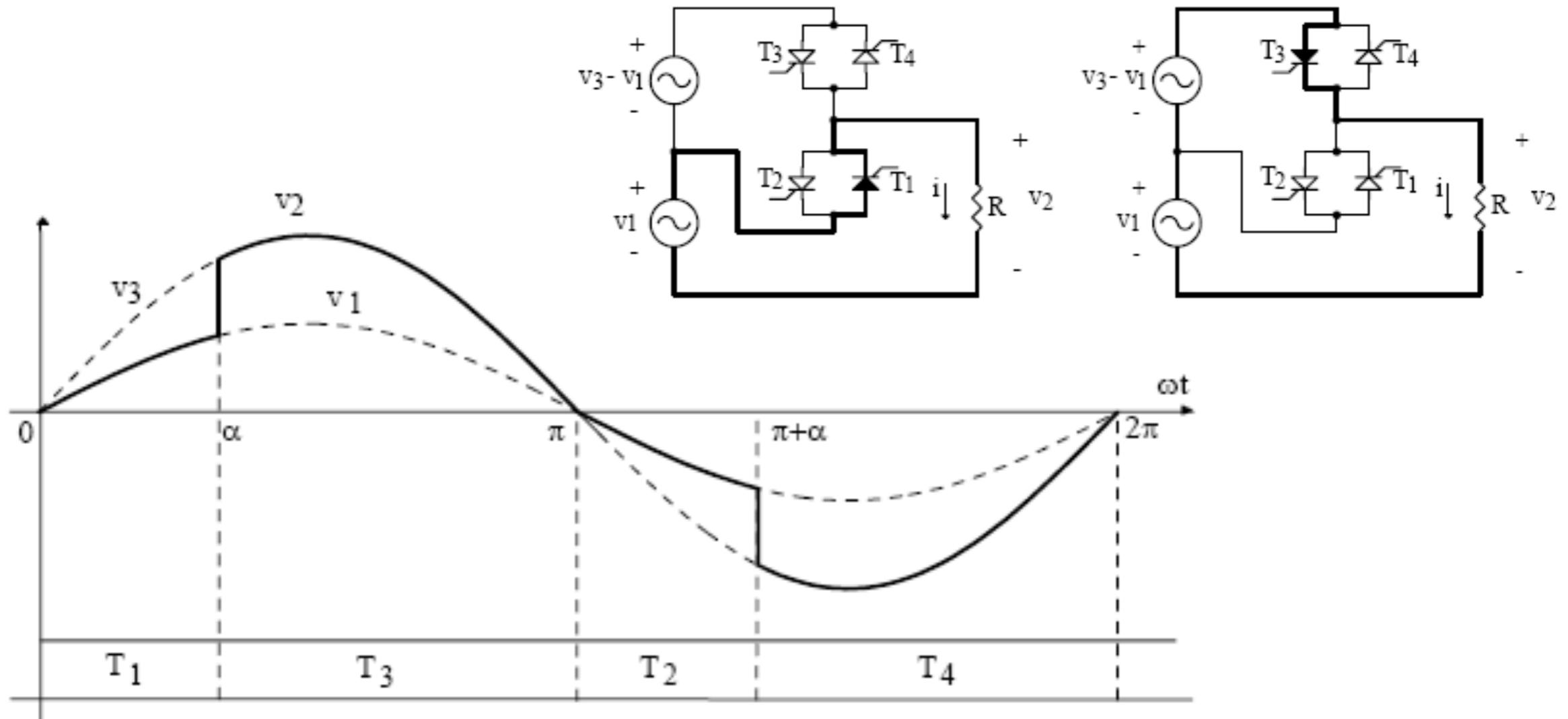
Product	Pb-Free	Status	Description	I_{TRMS} Max (A)	V_{DRM} Min (V)	V_{DRM} Max (V)	Package	Price
MKP1V120FL3	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	180	220	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V130FL3	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	120	180	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V180FL3	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	150	170	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V180FL3	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	150	170	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V240	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	120	180	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V240FL3	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	120	180	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V120	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	120	180	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V120FL3	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	120	180	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932
MKP1V240	Yes	Active	Sidac High Voltage Bidirectional Trigger	0.9	120	180	Radial Lead 5.25x0.75mm, 25.4x0.75mm Pkg. Lead len/da	10.2932

www.onsemi.com.br

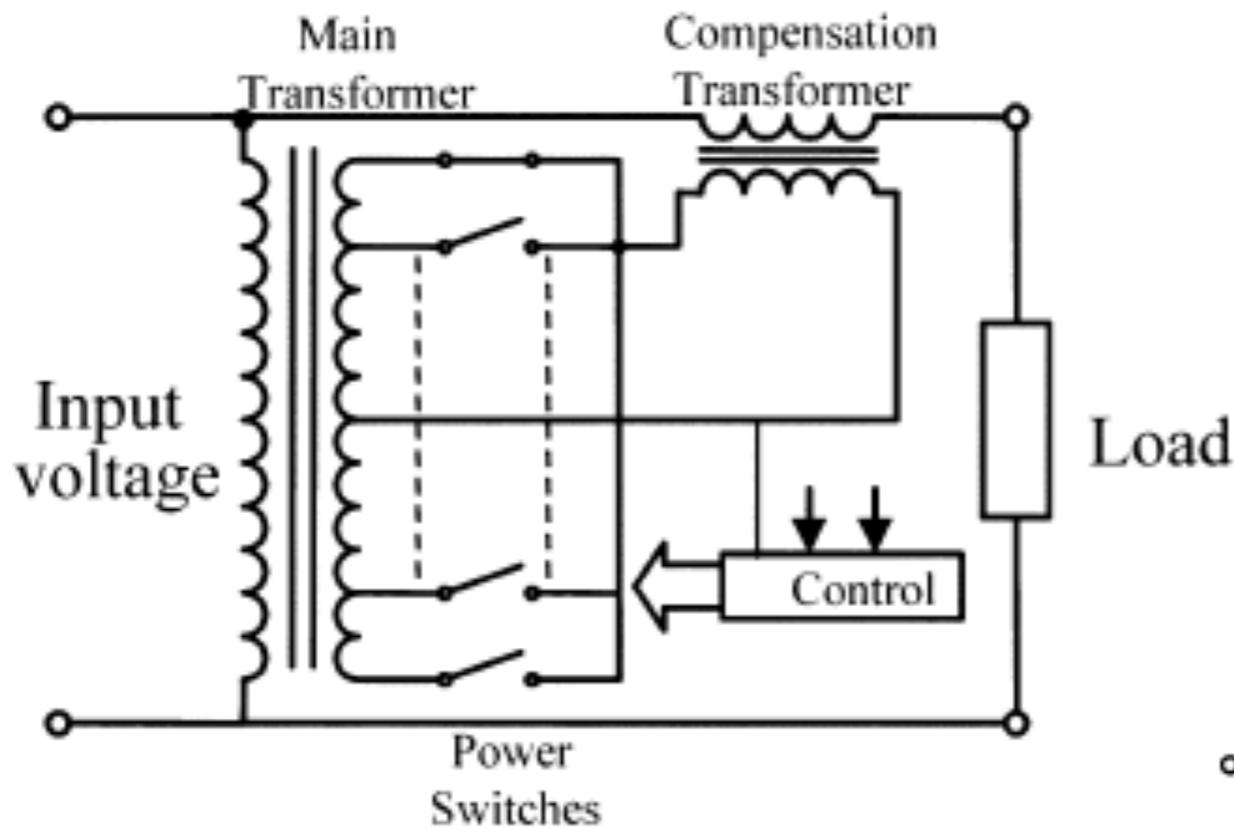
Estabilizador em Derivação (tap variável)



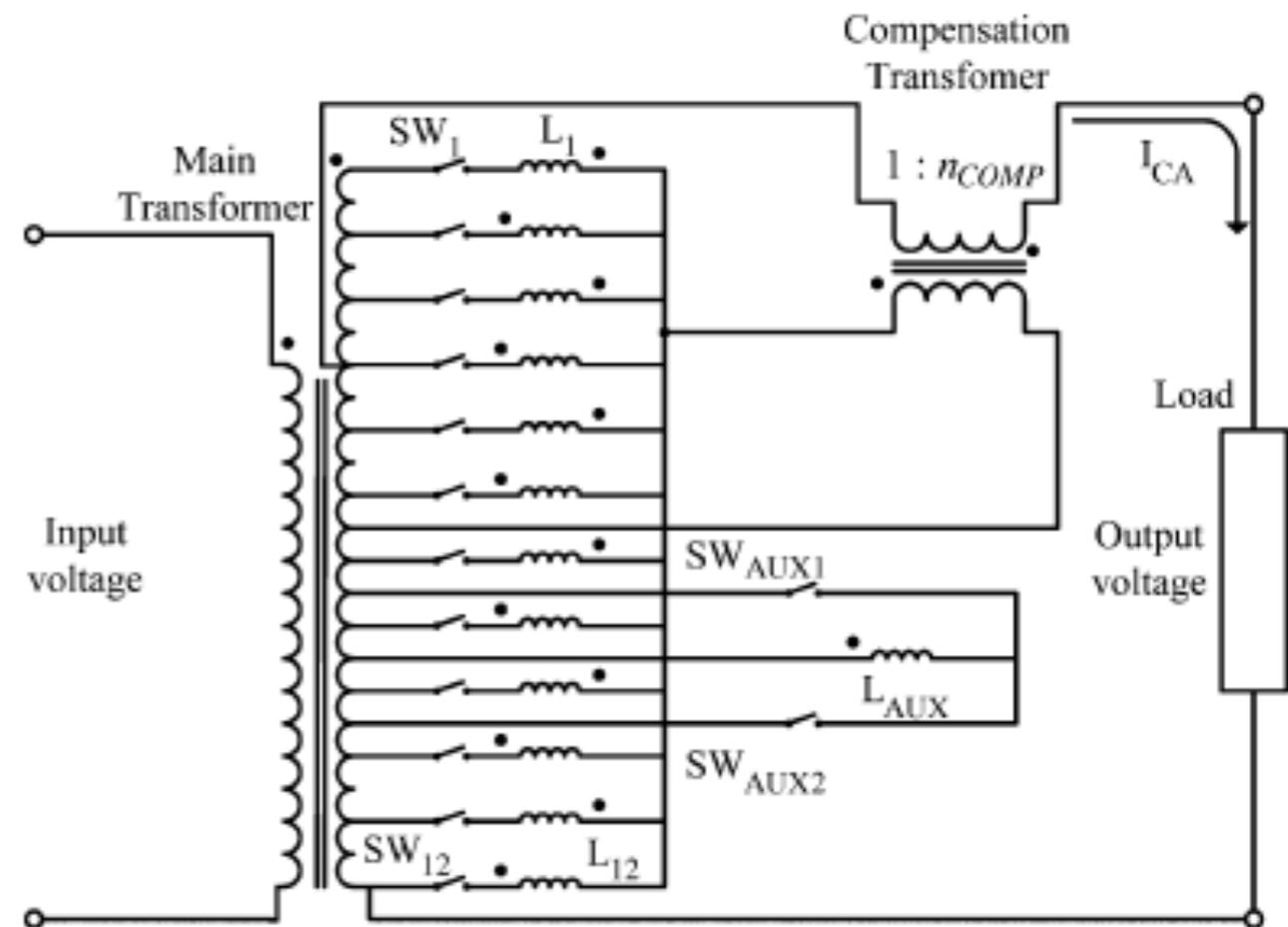
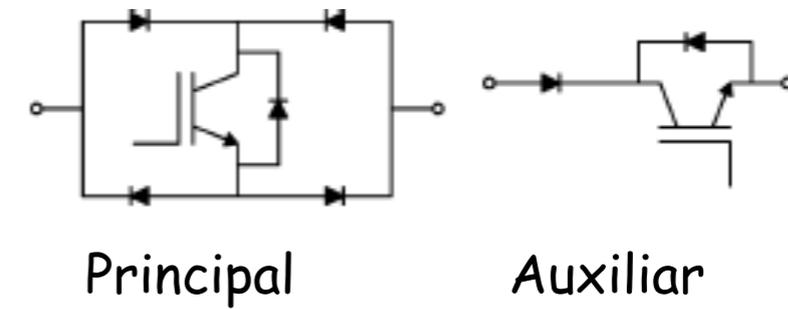
Estabilizador em Derivação (tap variável)



Estabilizador em Derivação (tap variável)



Echavarría et al, 2007.



Conversores ca-ca:

- Estabilizadores de tensão.

