Centro Federal de Educação Tecnológica de Santa Catarina
Departamento Acadêmico de Eletrônica
Conversores Estáticos

Conversores CA-CA
Variadores CA Monofásicos

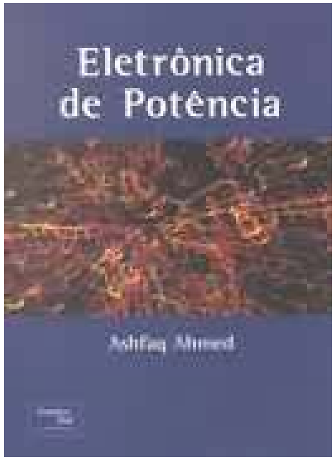
Prof. Clóvis Antônio Petry.

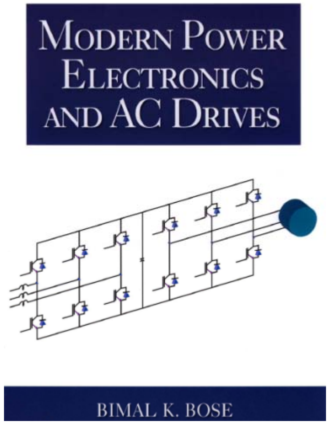
Florianópolis, setembro de 2008.

Bibliografia para esta aula

Capítulo 11: Controlador de tensão AC

1. Variadores CA monofásicos.





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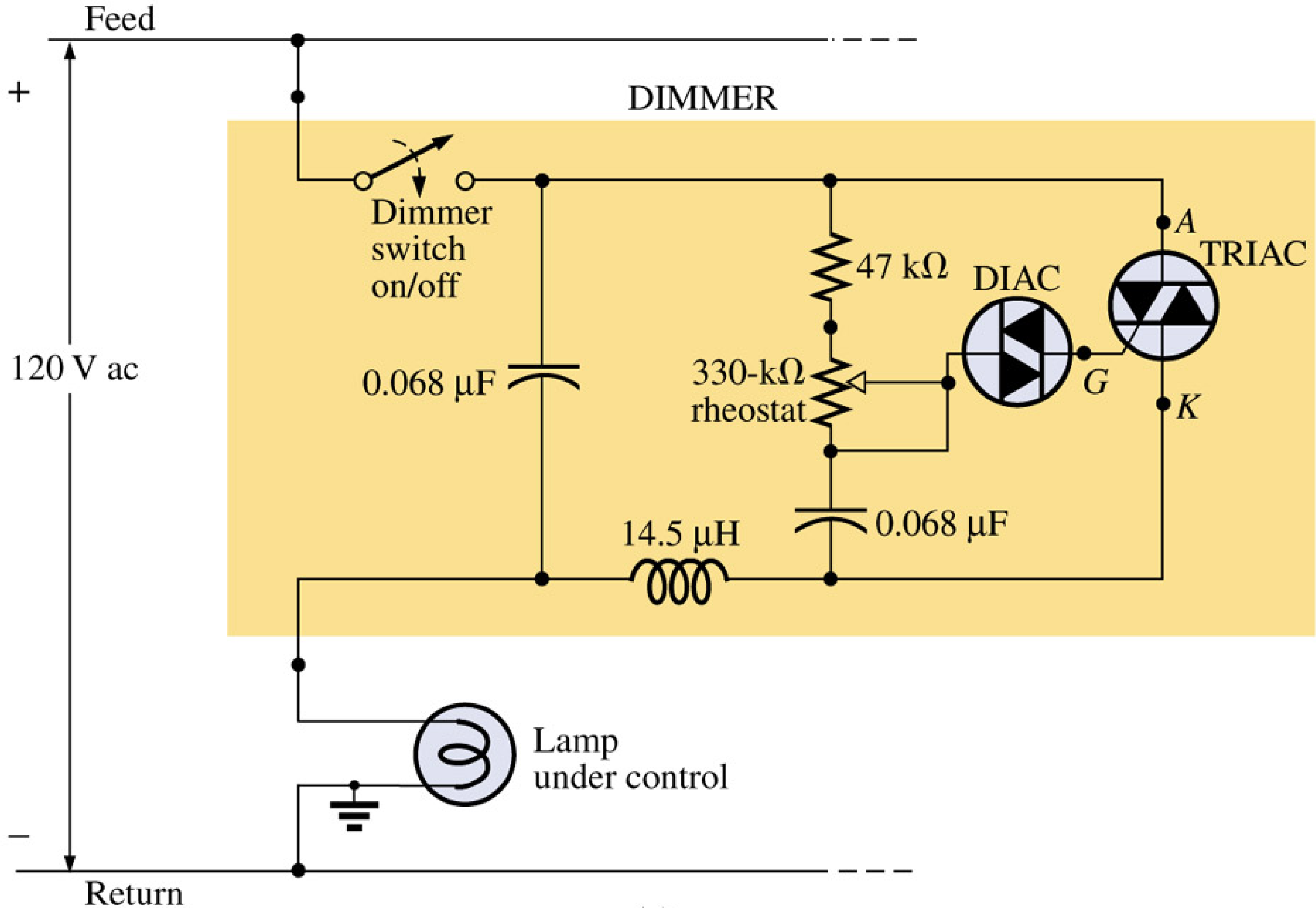
Nesta aula

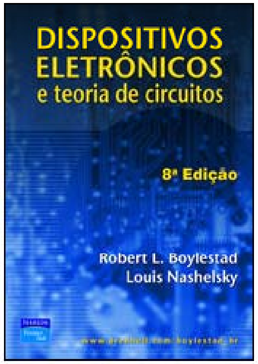
Gradadores:

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.

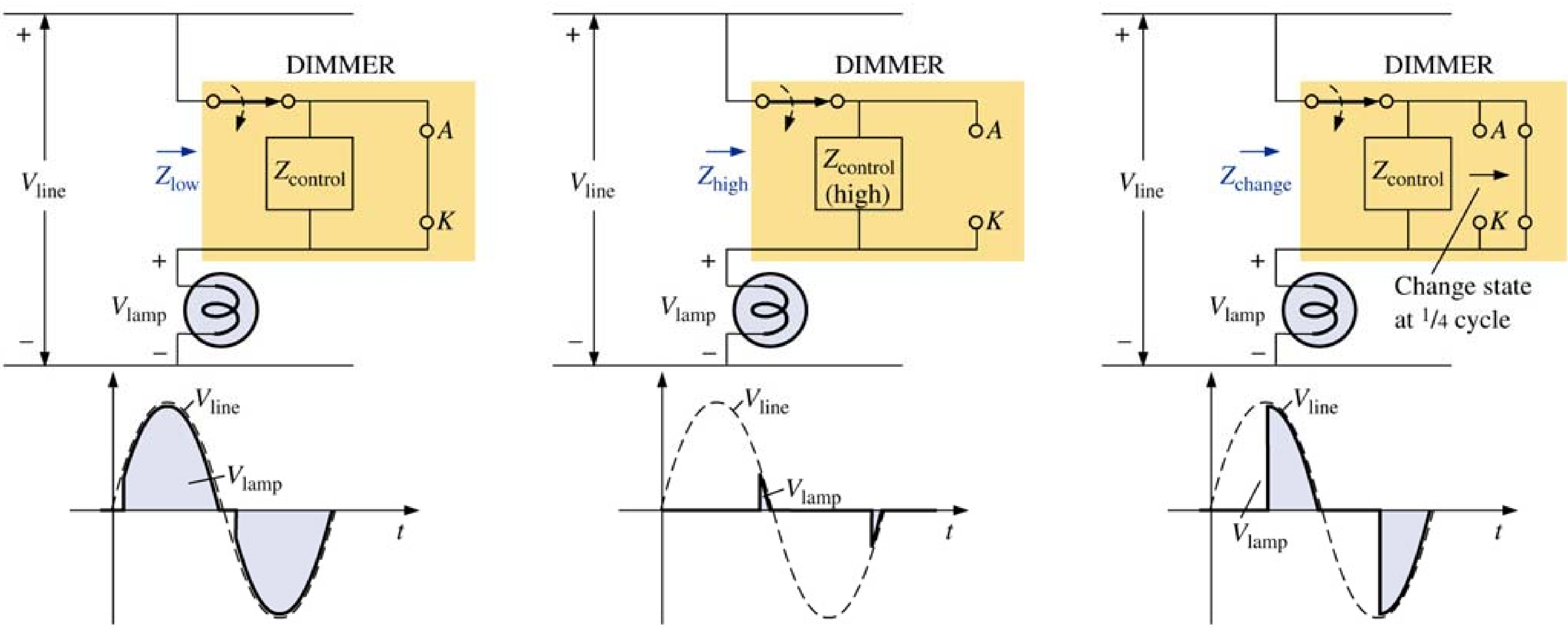
Implementação do gradador monofásico (dimmer)



(c)

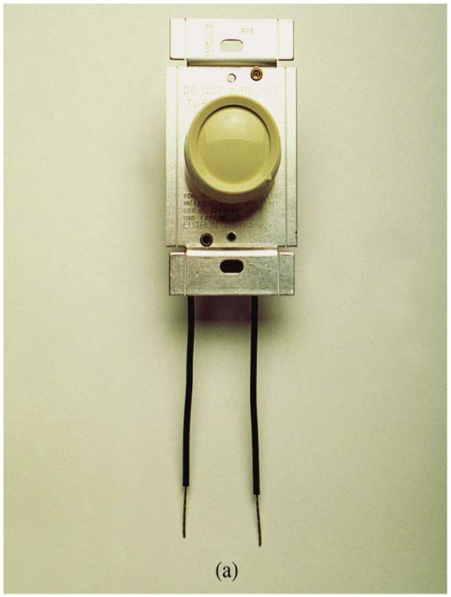


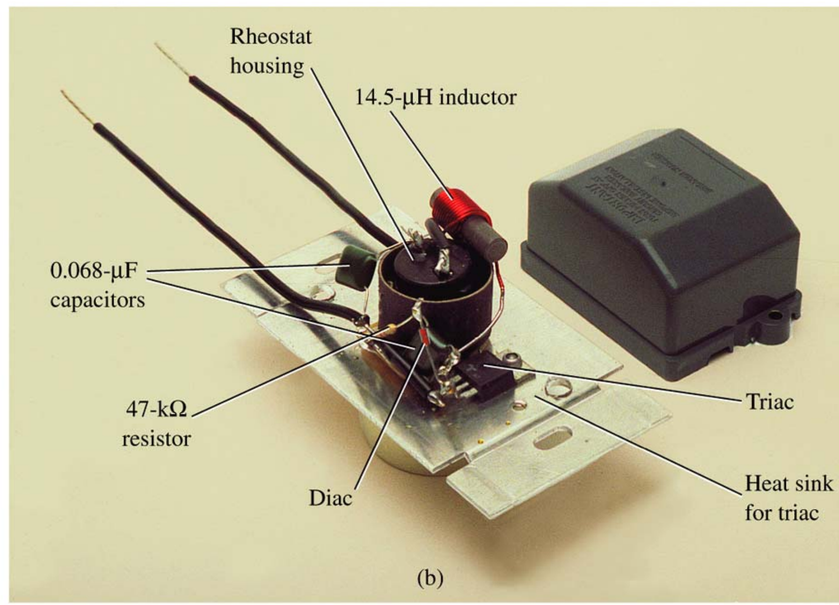
Implementação do gradador monofásico (dimmer)



(a) (b) (c)

Implementação do gradador monofásico (dimmer)

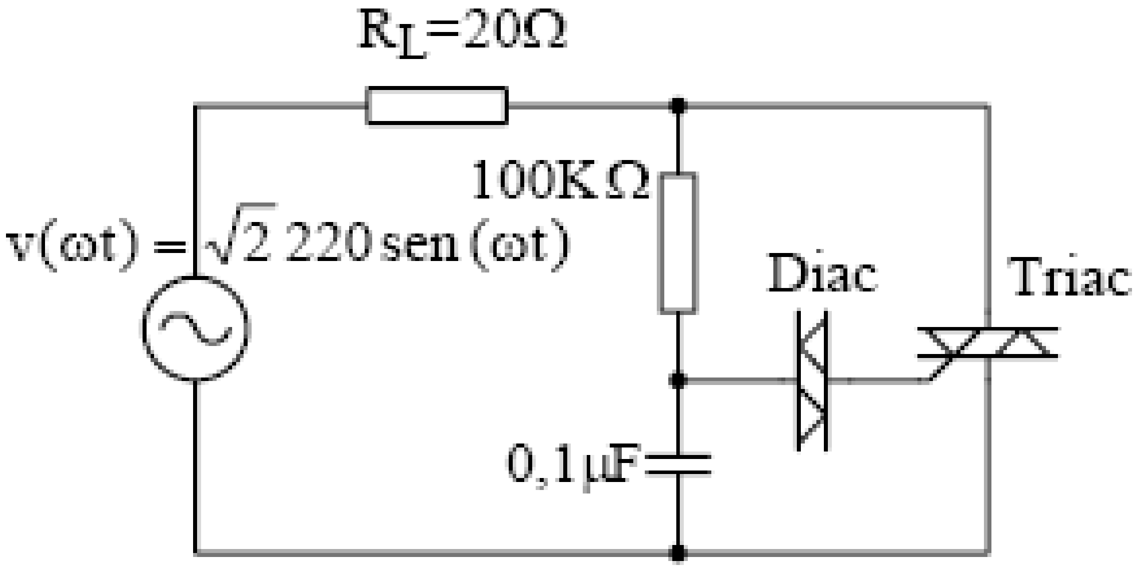




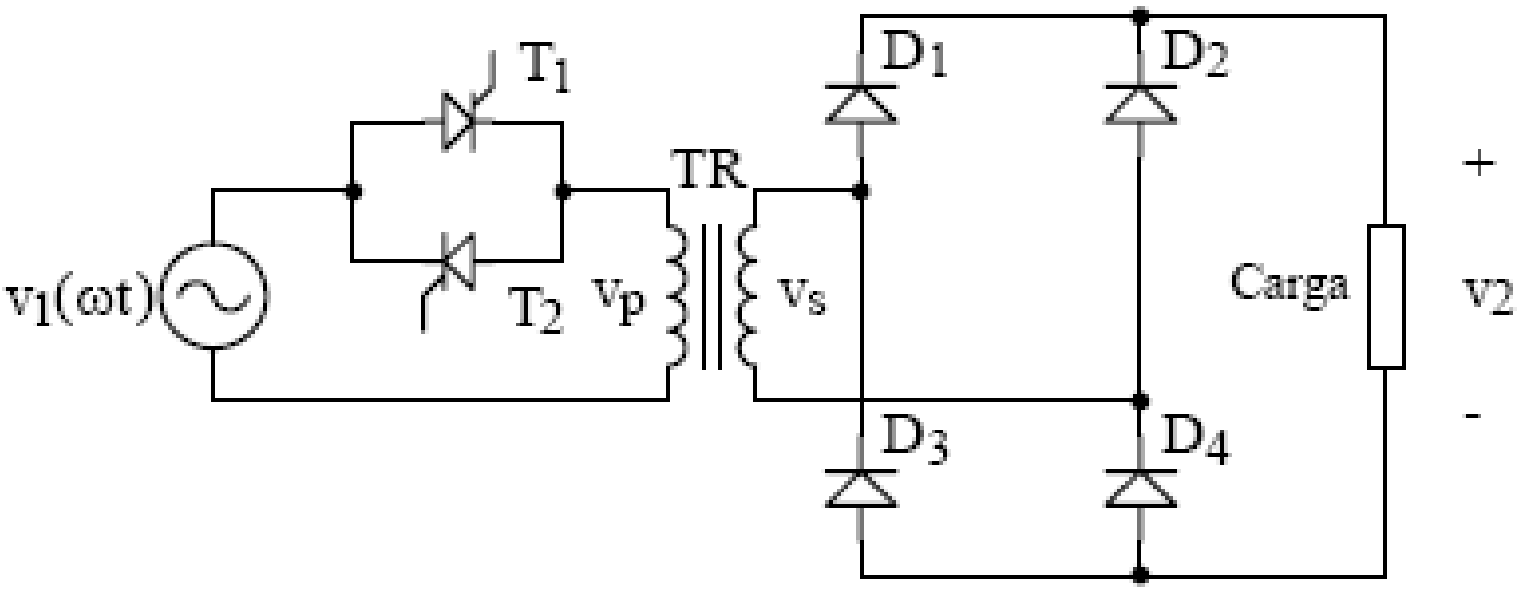
Implementação do gradador monofásico (dimmer)

Tarefa:
Estudar o exercício 6, do Capítulo 7 – Gradadores.

Diac de ± 42 V.

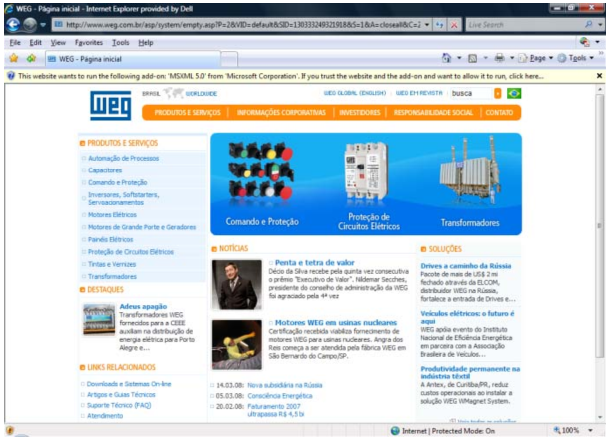


Partida de cargas com gradadores



Controle da tensão de saída do retificador pelo gradador

Partida de cargas com gradadores



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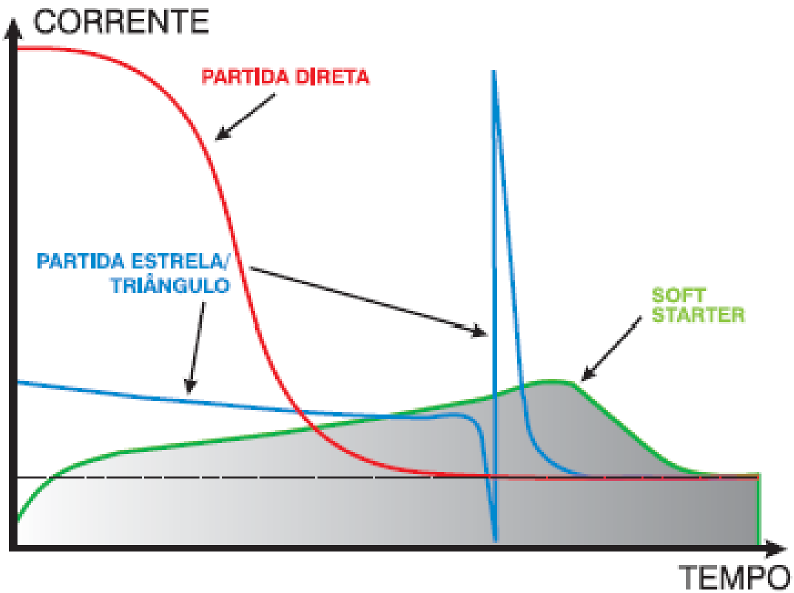
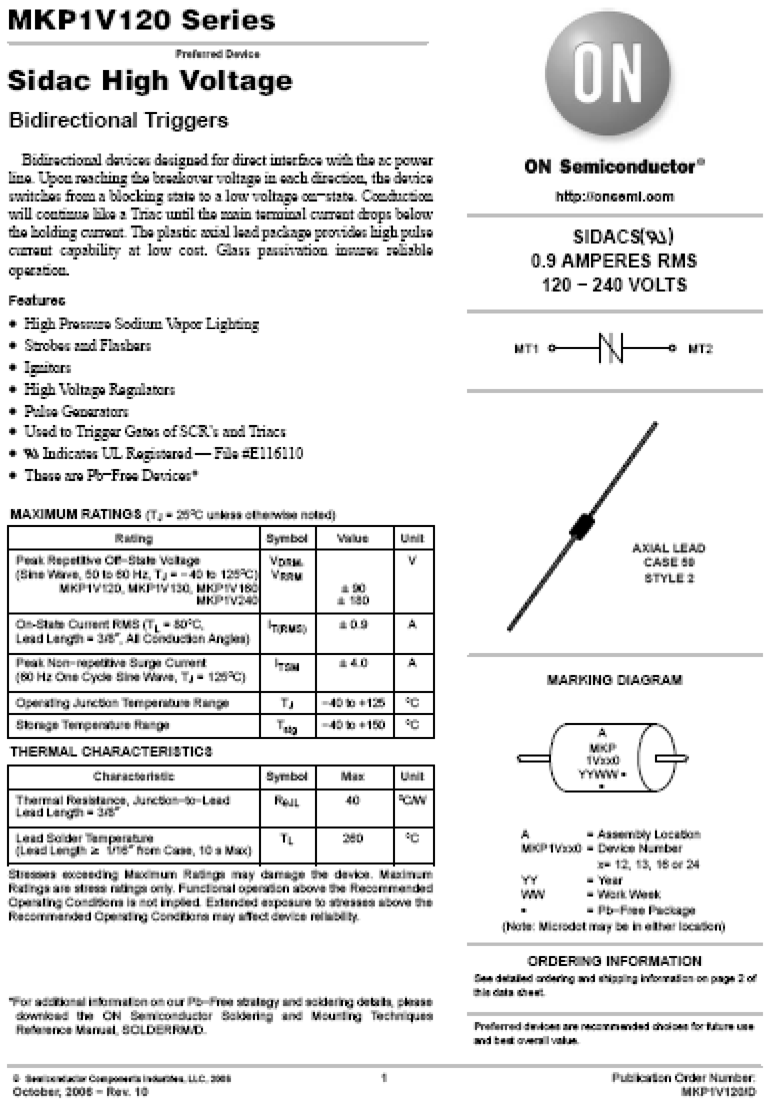


Controle da corrente de partida de motores usando gradadores

Disparo de 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
- Ignitors
- High Voltage Regulators
- Pulse Generators
- Used to Trigger Gates of SCR's and Triacs
- UL Indicates UL Registered — File #E116110
- These are Pb−Free Devices*

MAXIMUM RATINGS (T_J = 25°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, MKP1V160 MKP1V240	V_{DRM}, V_{RRM}	± 90 ± 180	V
On-State Current RMS (T_L = 80°C, Lead Length = 3/8″, All Conduction Angles)	$I_{T(RMS)}$	± 0.9	A
Peak Non−repetitive Surge Current (60 Hz One Cycle Sine Wave, T_J = 125°C)	I_{TSM}	± 4.0	A
Operating Junction Temperature Range	T_J	−40 to +125	°C
Storage Temperature Range	T_{stg}	−40 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Lead Lead Length = 3/8″	$R_{θJL}$	40	°C/W
Lead Solder Temperature (Lead Length ≥ 1/16″ from Case, 10 s Max)	T_L	260	°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(UL)
0.9 AMPERES RMS
120 − 240 VOLTS

MT1 MT2

AXIAL LEAD
CASE 59
STYLE 2

MARKING DIAGRAM

A
MKP
1Vxx0
YYWW•
•

A = Assembly Location
MKP1Vxx0 = Device Number
x= 12, 13, 16 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.

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October, 2006 − Rev. 10

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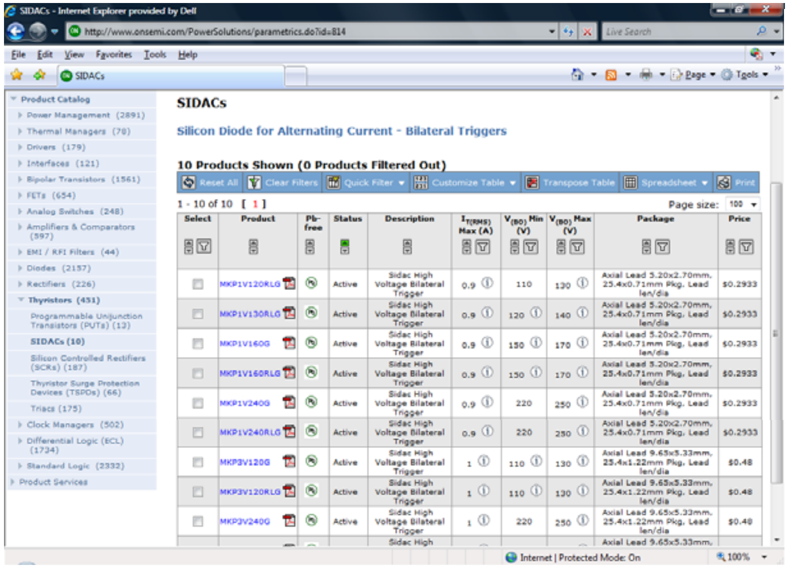
Publication Order Number:
MKP1V120/D



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http://www.onsemi.com/PowerSolutions/parametrics.do?id=814

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SIDACs

Product Catalog
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- Drivers (179)
- Interfaces (121)
- Bipolar Transistors (1561)
- FETs (654)
- Analog Switches (248)
- Amplifiers & Comparators (597)
- EMI / RFI Filters (44)
- Diodes (2157)
- Rectifiers (226)
- Thyristors (451)
  - Programmable Unijunction Transistors (PUTs) (13)
  - SIDACs (10)
  - Silicon Controlled Rectifiers (SCRs) (187)
  - Thyristor Surge Protection Devices (TSPDs) (66)
  - Triacs (175)
- Clock Managers (502)
- Differential Logic (ECL) (1724)
- Standard Logic (2332)
- Product Services

SIDACs

Silicon Diode for Alternating Current - Bilateral Triggers

10 Products Shown (0 Products Filtered Out)

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1 - 10 of 10 [1] Page size: 100

Select	Product	Pb-free	Status	Description	$I_{T(RMS)}$ Max (A)	$V_{(BO)}$ Min (V)	$V_{(BO)}$ Max (V)	Package	Price
	MKP1V120RLG		Active	Sidac High Voltage Bilateral Trigger	0.9	110	130	Axial Lead 5.20x2.70mm, 25.4x0.71mm Pkg. Lead len/dia	$0.2933
	MKP1V130RLG		Active	Sidac High Voltage Bilateral Trigger	0.9	120	140	Axial Lead 5.20x2.70mm, 25.4x0.71mm Pkg. Lead len/dia	$0.2933
	MKP1V160G		Active	Sidac High Voltage Bilateral Trigger	0.9	150	170	Axial Lead 5.20x2.70mm, 25.4x0.71mm Pkg. Lead len/dia	$0.2933
	MKP1V160RLG		Active	Sidac High Voltage Bilateral Trigger	0.9	150	170	Axial Lead 5.20x2.70mm, 25.4x0.71mm Pkg. Lead len/dia	$0.2933
	MKP1V240G		Active	Sidac High Voltage Bilateral Trigger	0.9	220	250	Axial Lead 5.20x2.70mm, 25.4x0.71mm Pkg. Lead len/dia	$0.2933
	MKP1V240RLG		Active	Sidac High Voltage Bilateral Trigger	0.9	220	250	Axial Lead 5.20x2.70mm, 25.4x0.71mm Pkg. Lead len/dia	$0.2933
	MKP3V120G		Active	Sidac High Voltage Bilateral Trigger	1	110	130	Axial Lead 9.65x5.33mm, 25.4x1.22mm Pkg. Lead len/dia	$0.48
	MKP3V120RLG		Active	Sidac High Voltage Bilateral Trigger	1	110	130	Axial Lead 9.65x5.33mm, 25.4x1.22mm Pkg. Lead len/dia	$0.48
	MKP3V240G		Active	Sidac High Voltage Bilateral Trigger	1	220	250	Axial Lead 9.65x5.33mm, 25.4x1.22mm Pkg. Lead len/dia	$0.48

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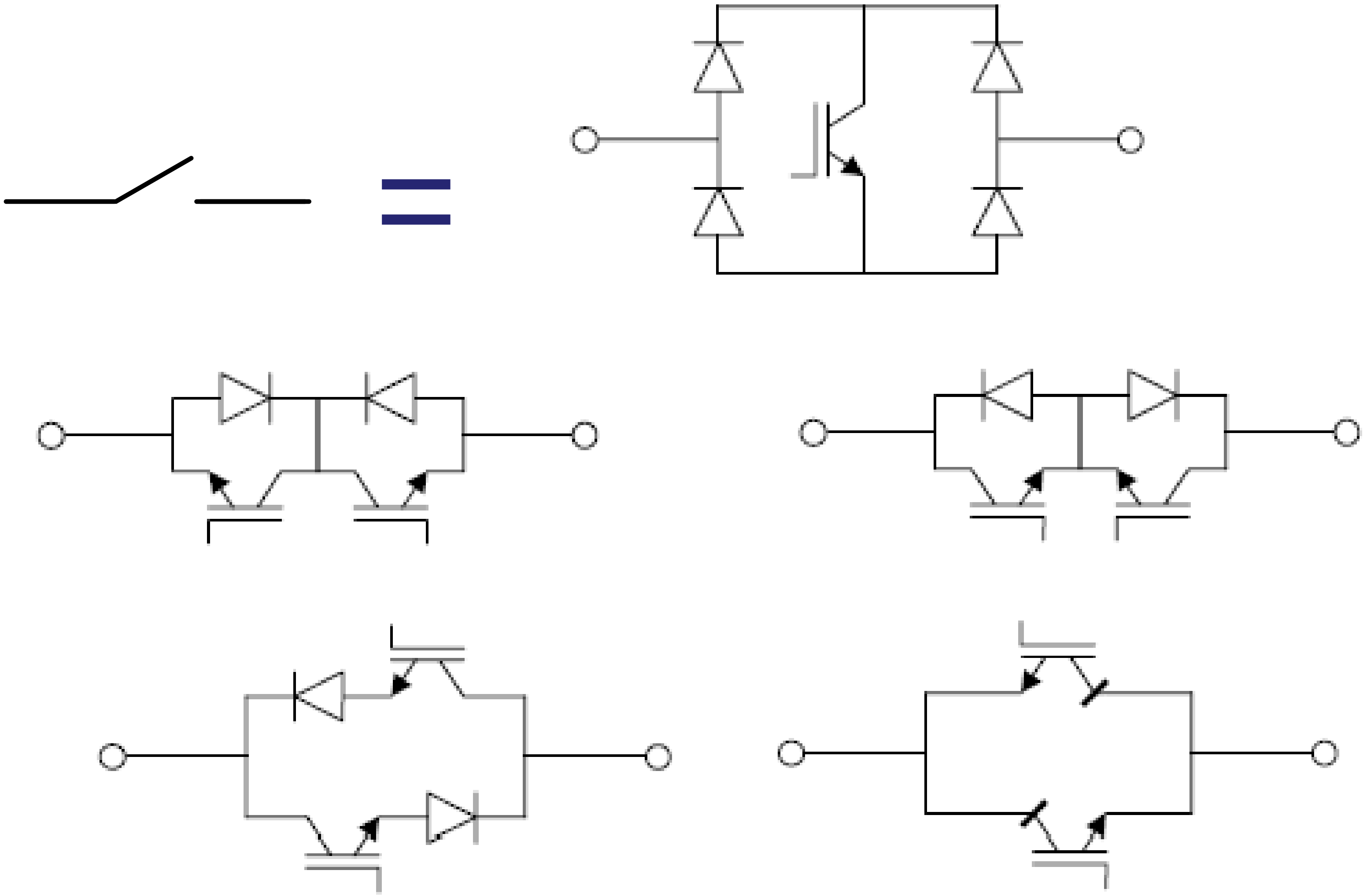
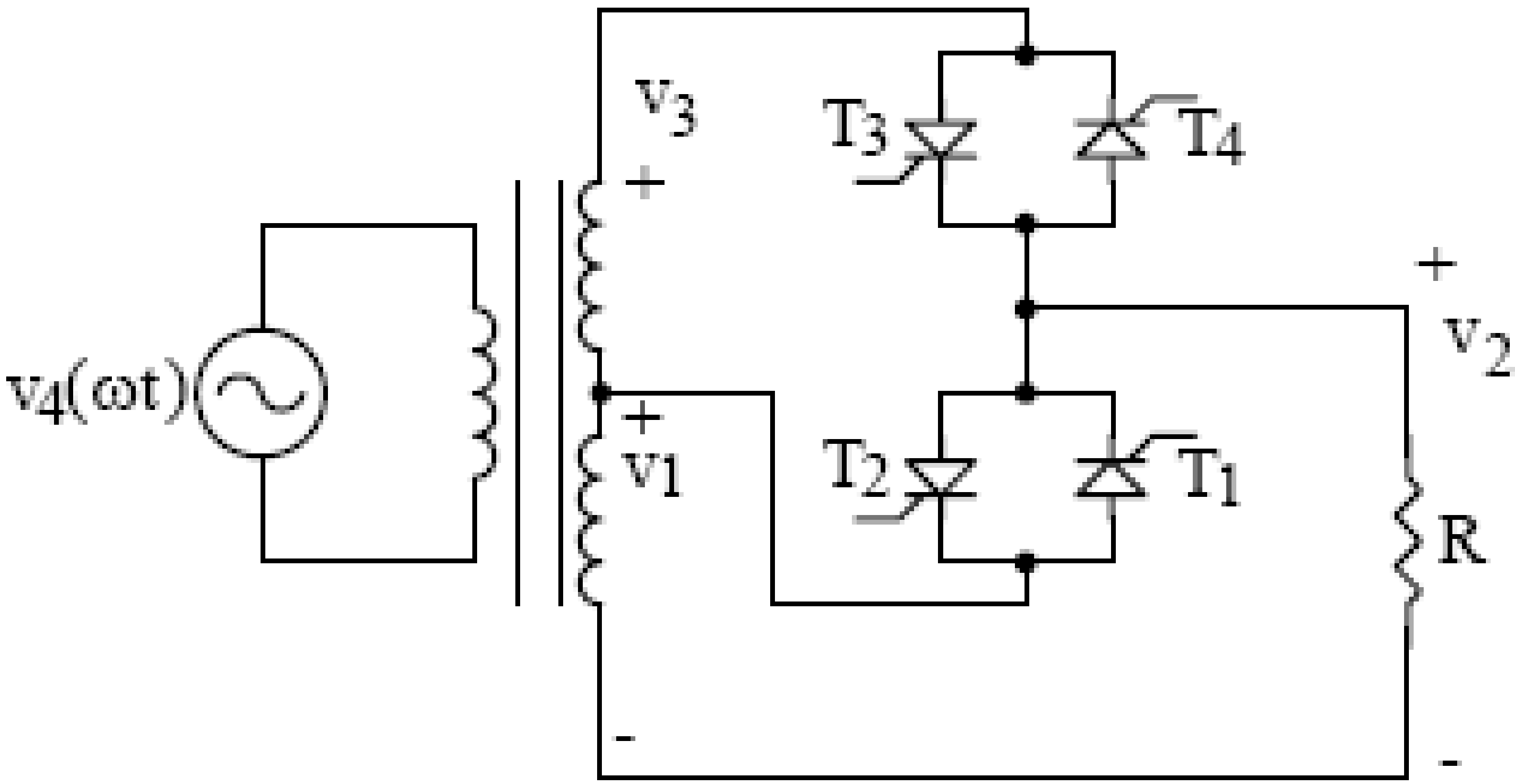
Chaves bidirecionais para conversores CA-CA



Estabilizador com tap variável



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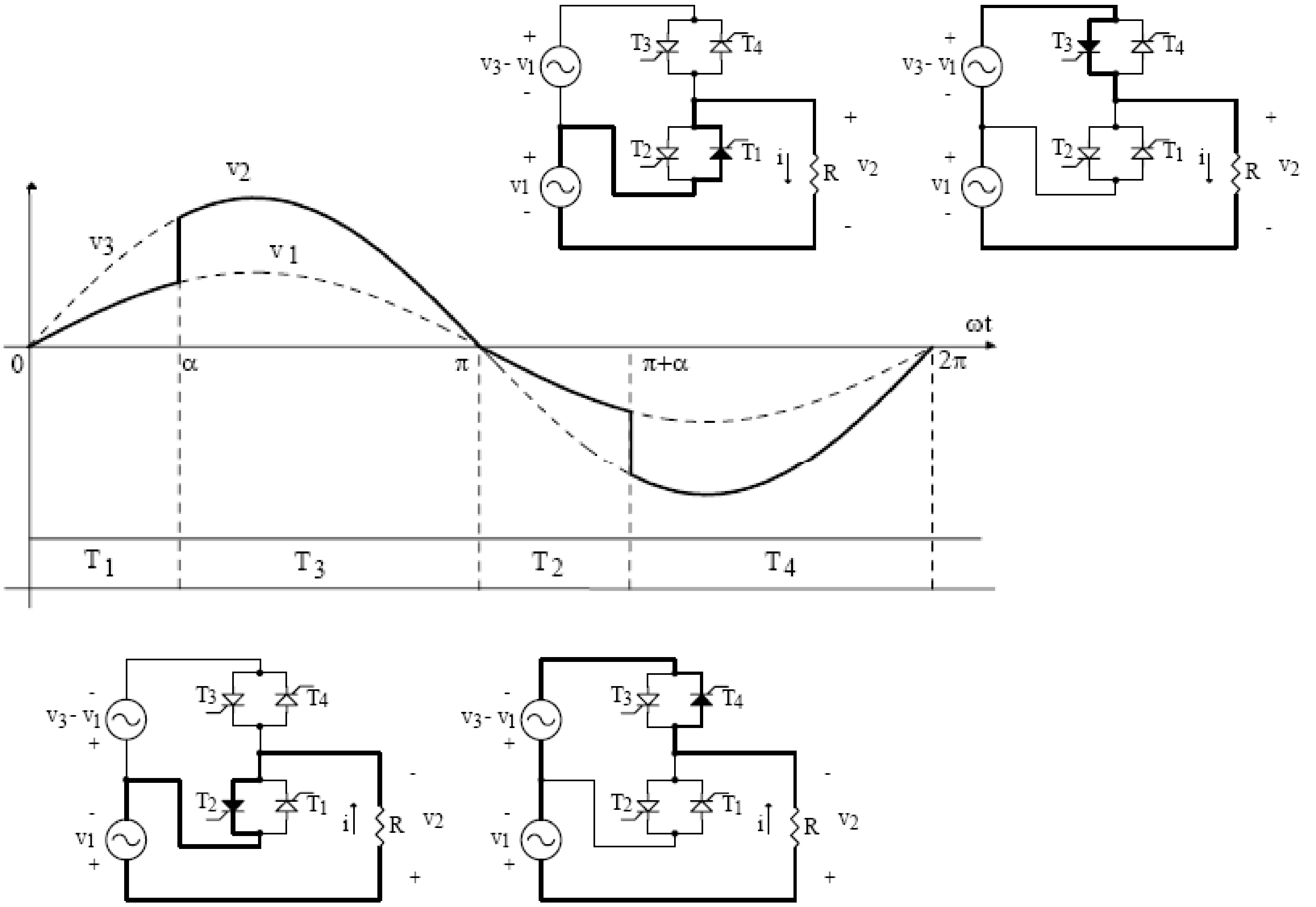

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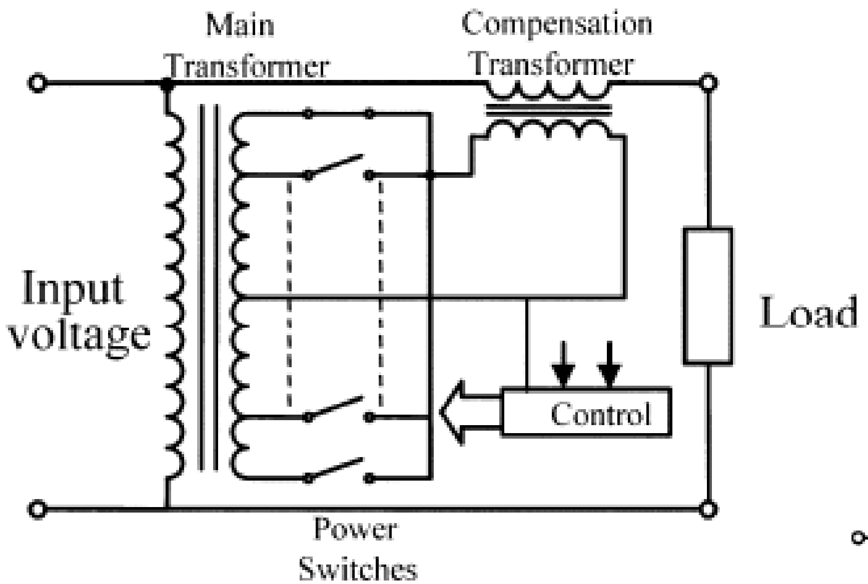
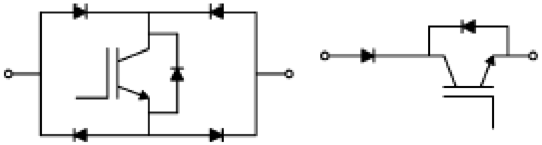
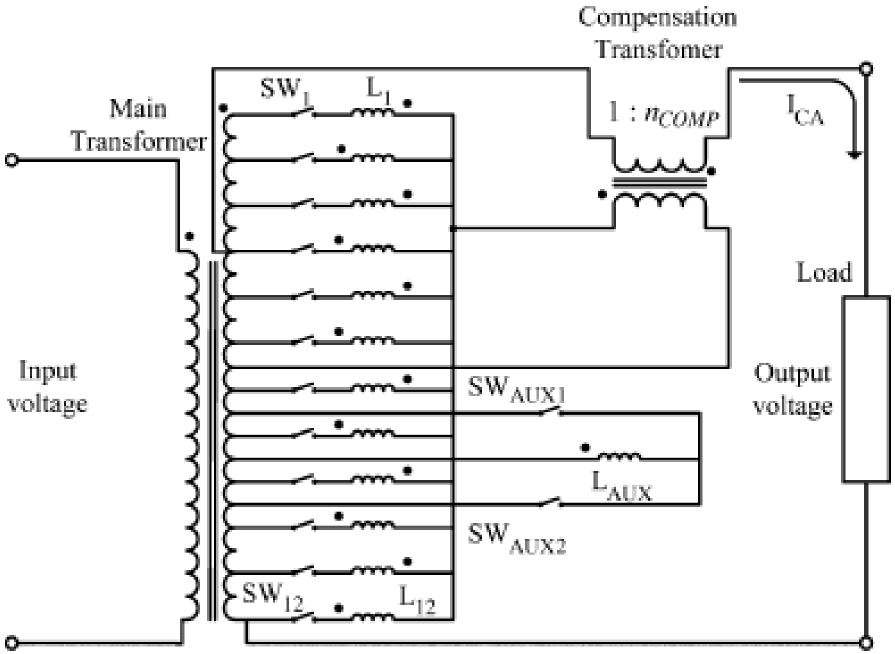
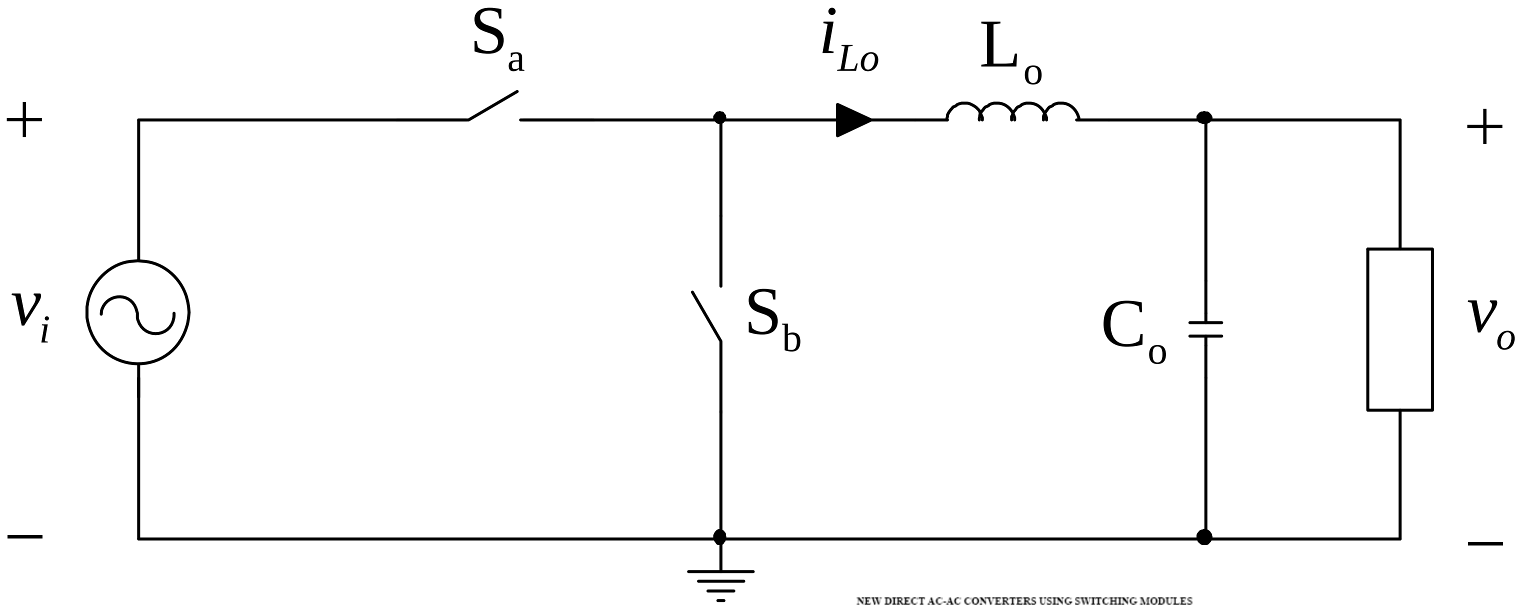




Echavarría et al, 2007.



Chopper CA-CA



NEW DIRECT AC-AC CONVERTERS USING SWITCHING MODULES WITHOUT COMMUTATION PROBLEMS

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Abstract **– In this paper the study of direct AC-AC converter topologies, which make use of switches in commercial settings, will be performed. Several topologies are presented, including some already known in the literature and new ones. For one of the presented topologies, the design of a 3 kVA line conditioner is developed and experimental results are shown, certifying the correct operation of the drive strategy used.**

Keywords **– direct converters, AC-AC converters, line conditioner, switching modules.**

I. INTRODUCTION

Line conditioners are equipment used in industrial, residential and commercial environments in order to regulate the voltage provided by the grid. One of the main difficulties of employing alternating current converters using fast switches and PWM has always been the switching, which remained without a solution for many years. Observing Fig. 2 it can be seen that in order to switch from S_1/S_3 to S_2/S_4 there are two alternatives: the superposition of the drive signals or the use of dead-time. In the first case, a short-circuit in the voltage source is provoked, while in the second case the current through inductor L_o is interrupted, resulting in overvoltages across the switches [14].

One solution for the switching problem is the use of indirect converters [1], which inconveniently use a larger number of switches than direct converters.

A switching proposal for AC-AC converters was presented in [2] and improved in [3-7], eliminating the need for clamping circuits. In this switching strategy it is necessary to synchronize the drive signals with the converter's input voltage signal.

In [8] a switching cell was proposed for direct AC-AC converters, studied later in [9]. These converters are robust, with few controlled switches and solve the switching problem. However, there is a problem with average current through the inductors and switches cannot be used in commercial configurations.

The arrangement of the switches in commercial configurations for AC-AC converters were proposed in [4-7, 10]. These arrangements allow the use of commercial modules, an attractive feature especially at high power.

The main idea of this work is to employ the switching strategies of [3-7] in several topologies, among which some are well known and others are new, always using switches arranged in a way that permits the usage of commercial modules [4-7, 10].

In [11] several converters topologies were proposed, however, the main focus was neither on switching nor on the commercial arrangement of the switches. In this manner, among the topologies presented in this paper, one was chosen to implement a 3 kVA line conditioner, controlled by the orthogonal detection principle [12, 13].

II. ORIGIN AND COMMUTATION OF THE PROPOSED TOPOLOGIES

To show the origin of the topologies that are going to be presented, an AC-AC Buck converter in a standard configuration will be shown, as depicted in Fig. 2. Note that this converter is bidirectional in both voltage and current by using commercial switches. However, the usage of commercial modules is not possible. Altering the position of switch S_3, a configuration which allows the usage of commercial modules is obtained, as shown in Fig. 3.

The switching is performed as shown in Fig. 1; note that during the positive semi-cycle of the grid voltage, switches S_3 and S_4 conduct and switches S_1 and S_2 are driven by PWM. During the negative semi-cycle of the grid voltage, switches S_1 and S_2 conduct and switches S_3 and S_4 are modulated at high-frequency.

III. PROPOSED TOPOLOGIES

Using the same procedure adopted in Fig. 2, that is, rearranging the switches in a way to obtain configurations that allow the usage of commercial modules, several AC-AC converter topologies can be obtained. With these topologies several voltage compensating AC voltage conditioners can be implemented, which have the advantage of processing just the difference between the desired output voltage and the input voltage, consequently, processing just part of the load's power, guaranteeing a high performance. The static gain will be expressed as a function of the switches' duty-cycle and the turns ratios, for the structures that use transformers.

	$v_i > 0$	$v_i < 0$
S_1	pwm	on
S_2	pwm	on
S_3	on	pwm
S_4	on	pwm

Fig. 1 – Switching of the converter switches of Fig. 3.

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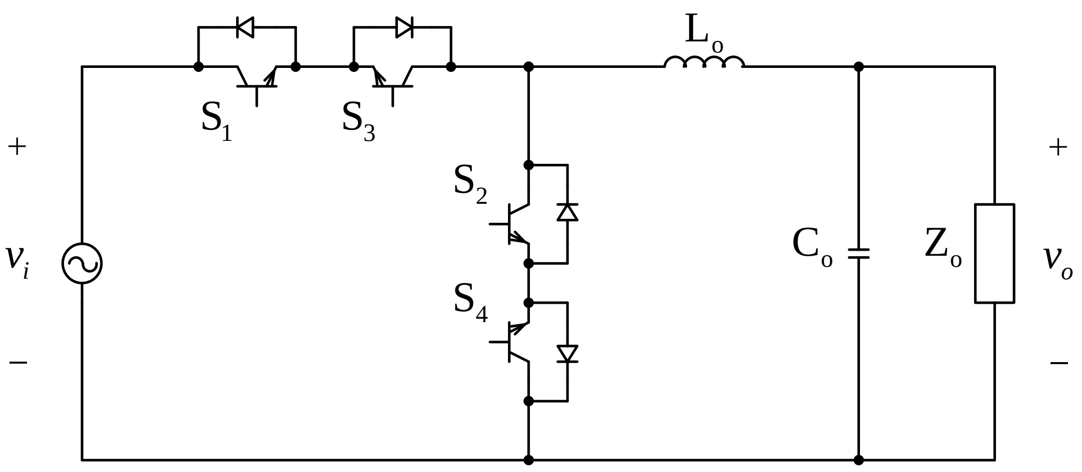
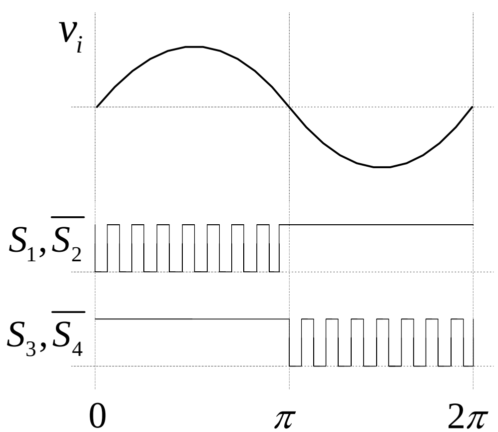
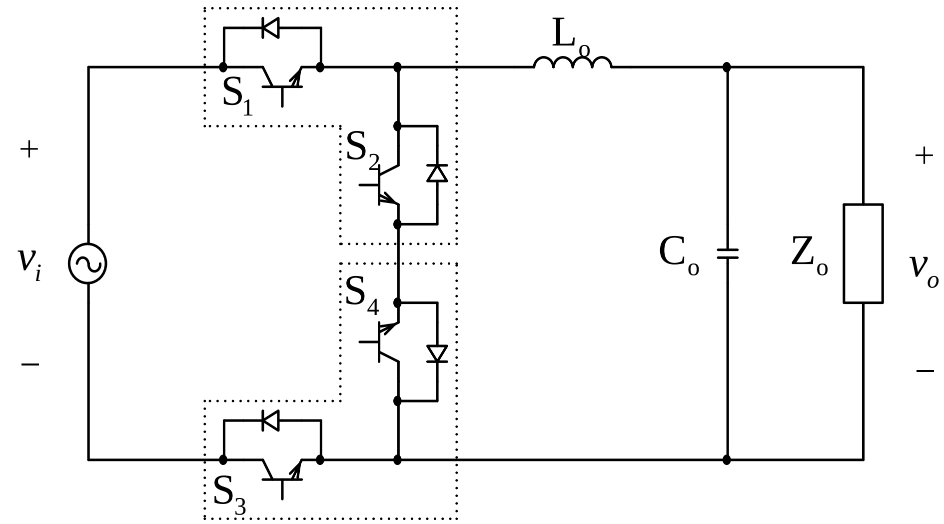
Chopper CA-CA





	$v_i > 0$	$v_i < 0$
S_1	*pwm*	*on*
S_2	*pwm*	*on*
S_3	*on*	*pwm*
S_4	*on*	*pwm*



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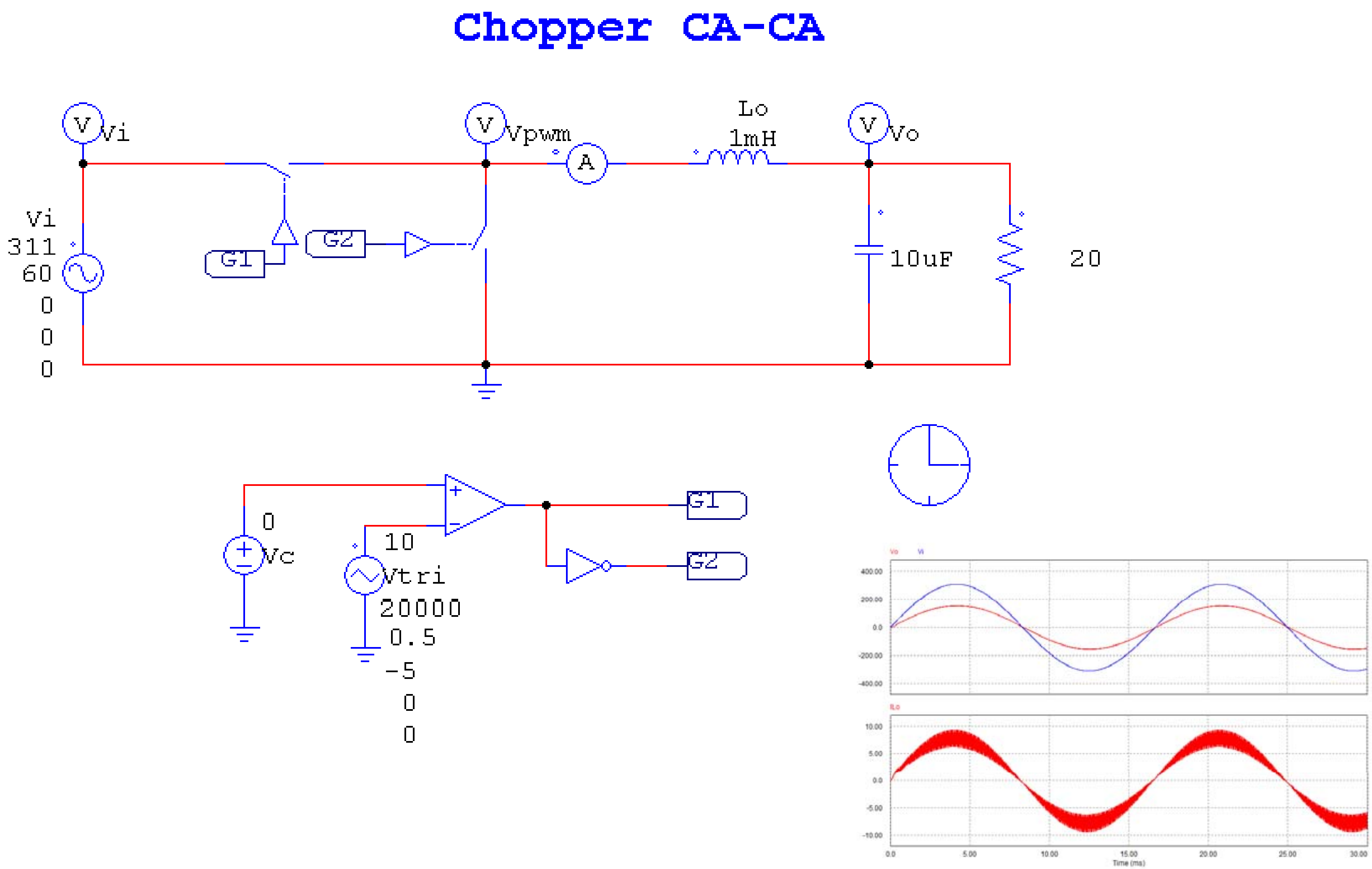

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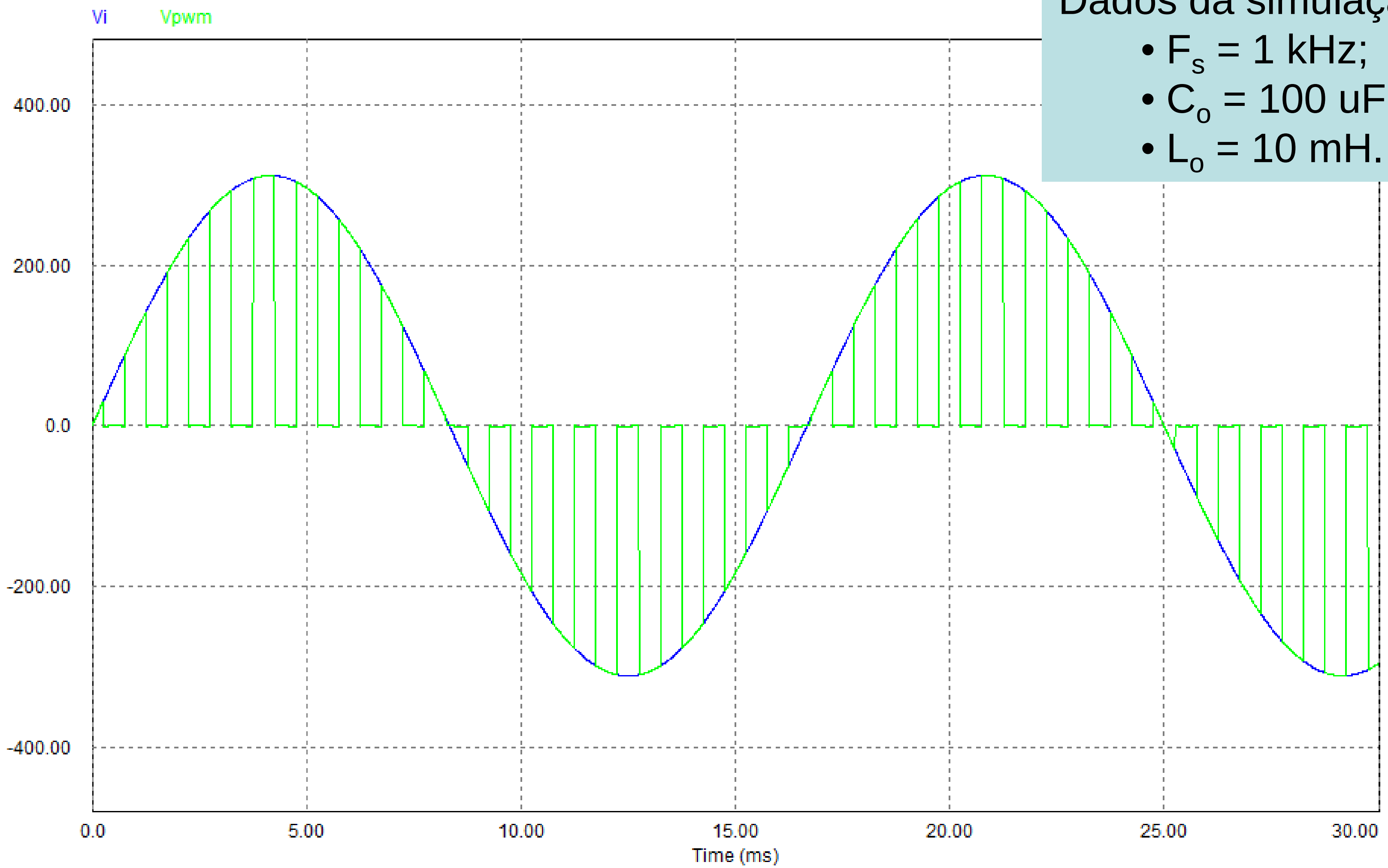
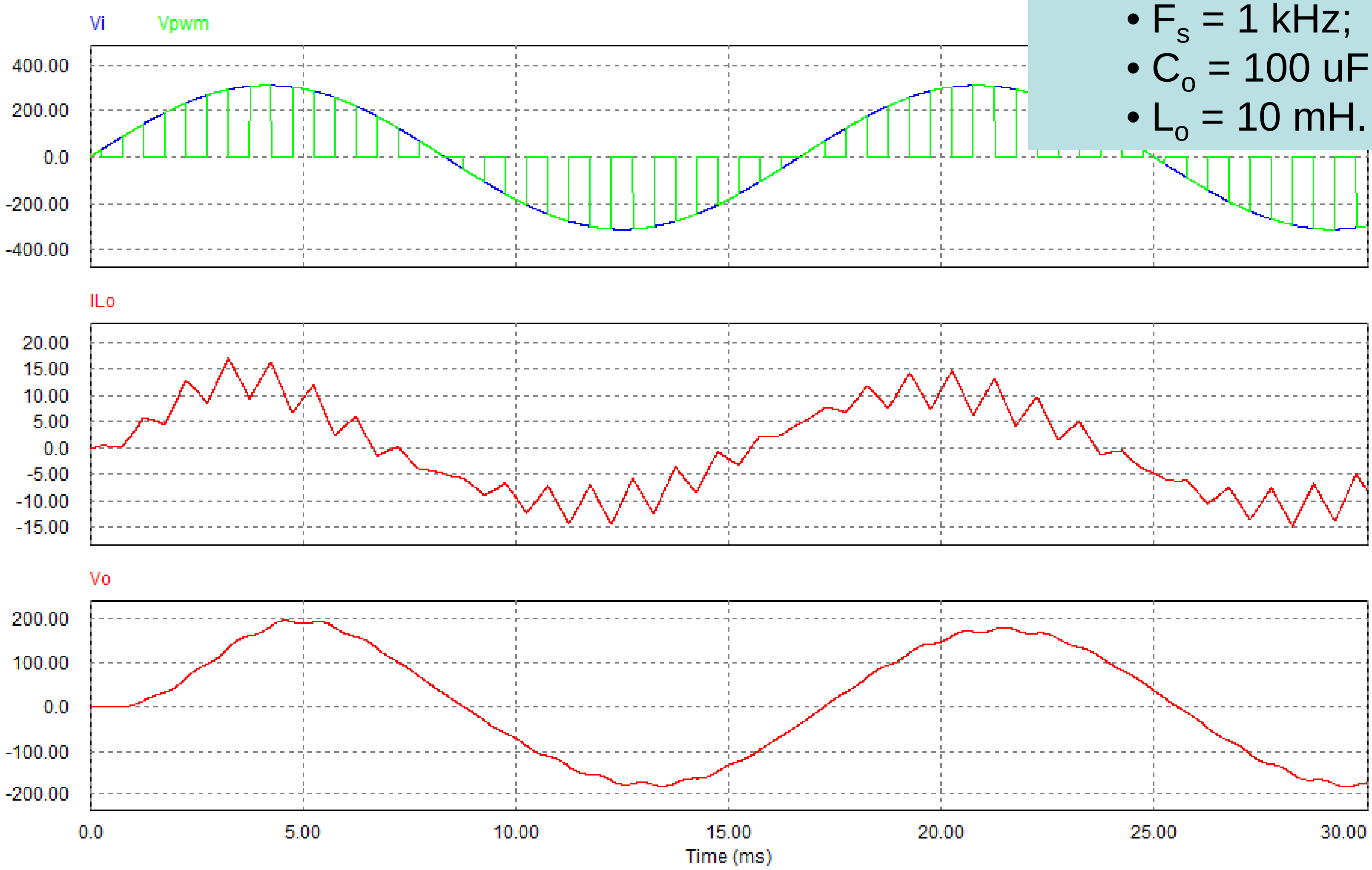


Dados da simulação:

- F_s = 1 kHz;
- C_o = 100 uF;
- L_o = 10 mH.

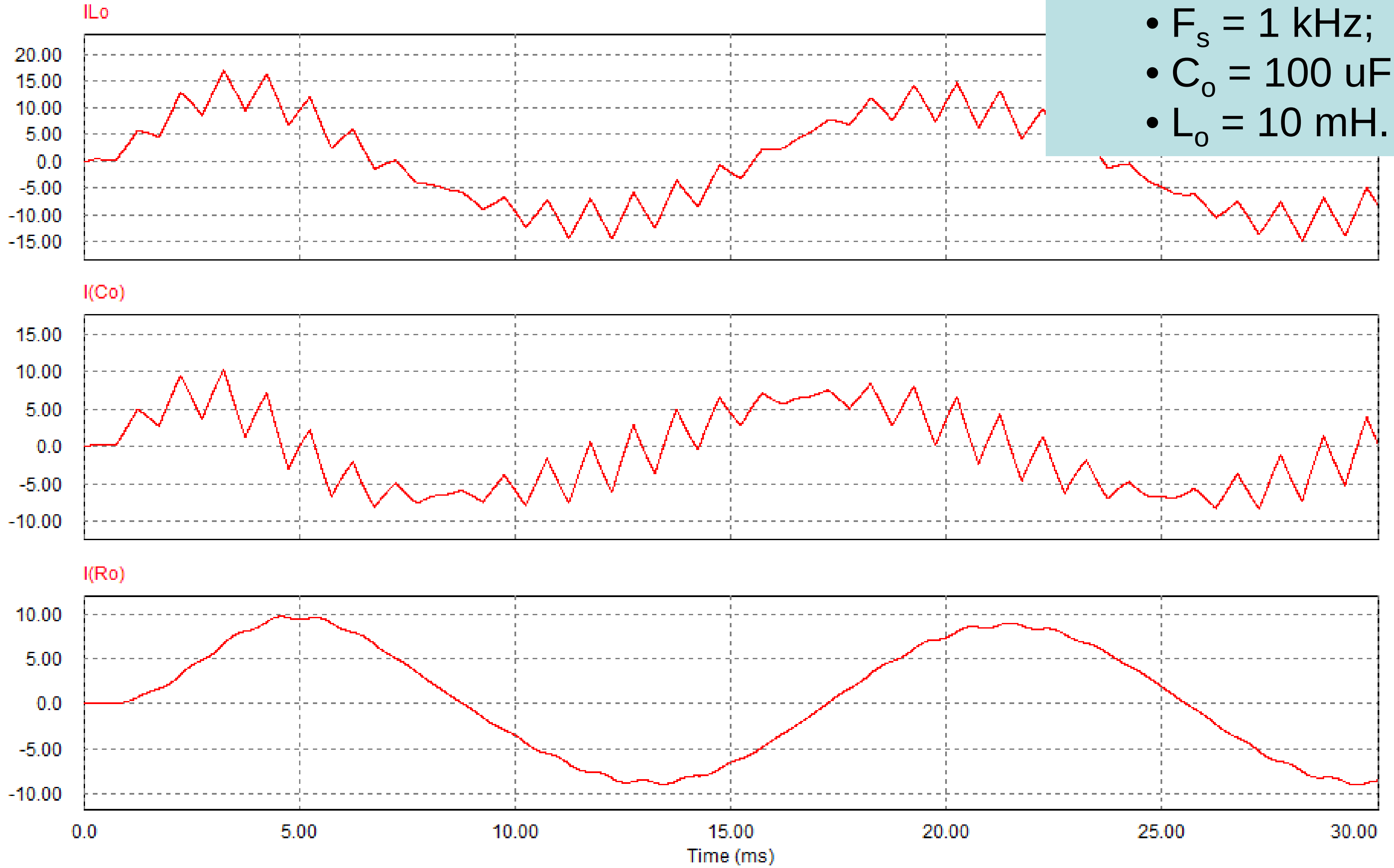
Chopper CA-CA



Dados da simulação:

- F_s = 1 kHz;
- C_o = 100 uF;
- L_o = 10 mH.

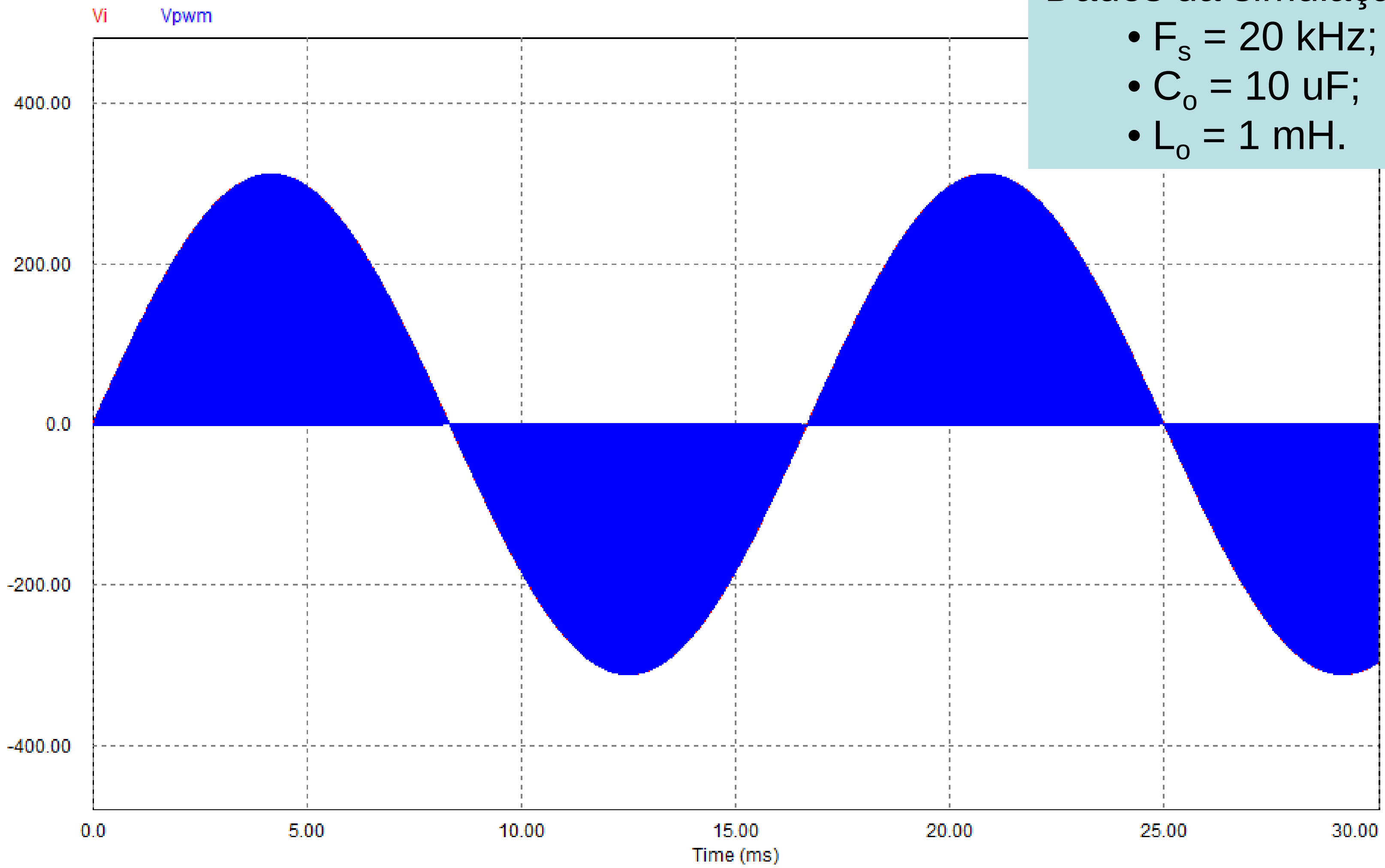
Chopper CA-CA



Dados da simulação:

- F_s = 1 kHz;
- C_o = 100 uF;
- L_o = 10 mH.

Chopper CA-CA



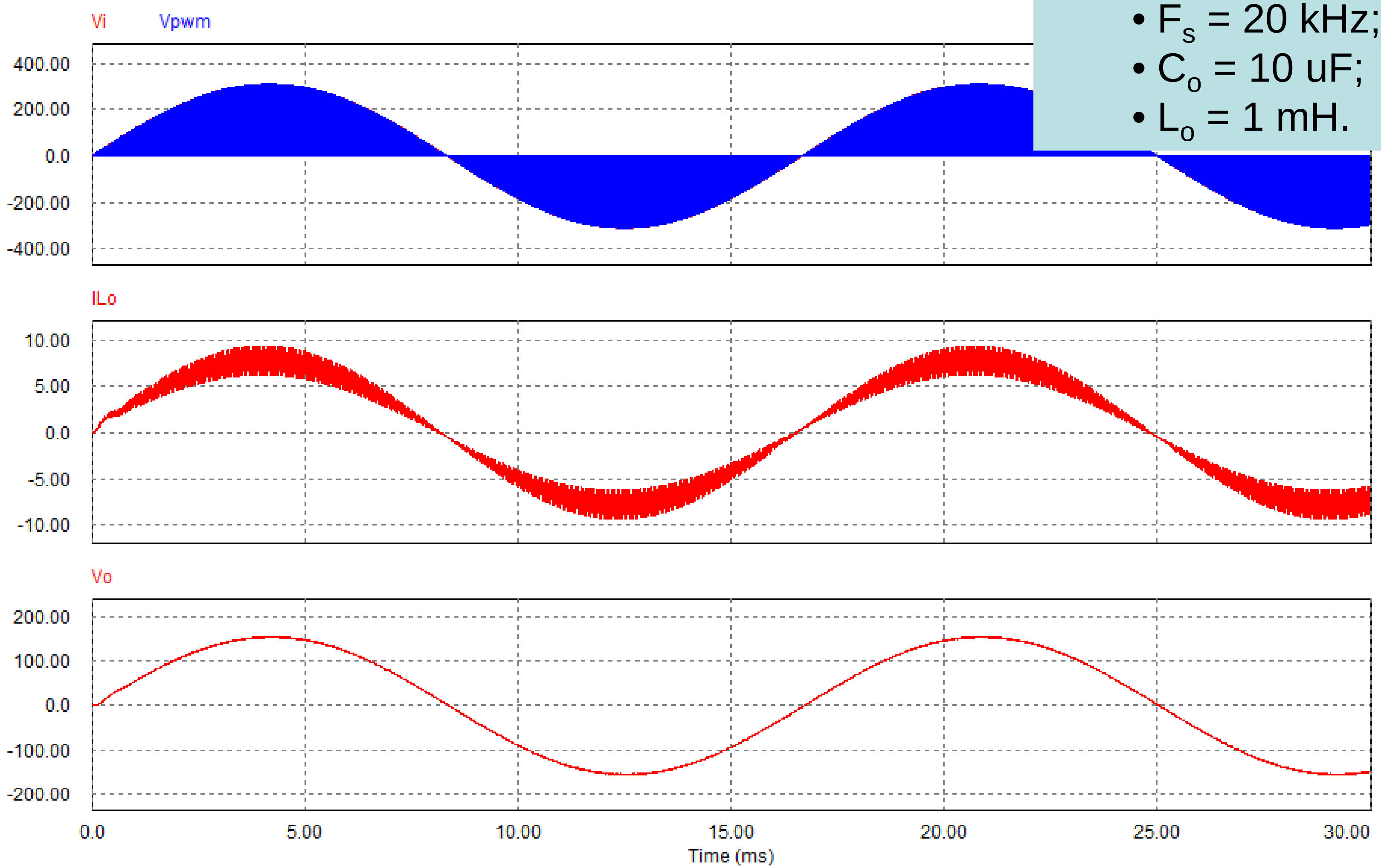
Dados da simulação:

- F_s = 20 kHz;
- C_o = 10 uF;
- L_o = 1 mH.

Chopper CA-CA

Dados da simulação:

- F_s = 20 kHz;
- C_o = 10 uF;
- L_o = 1 mH.



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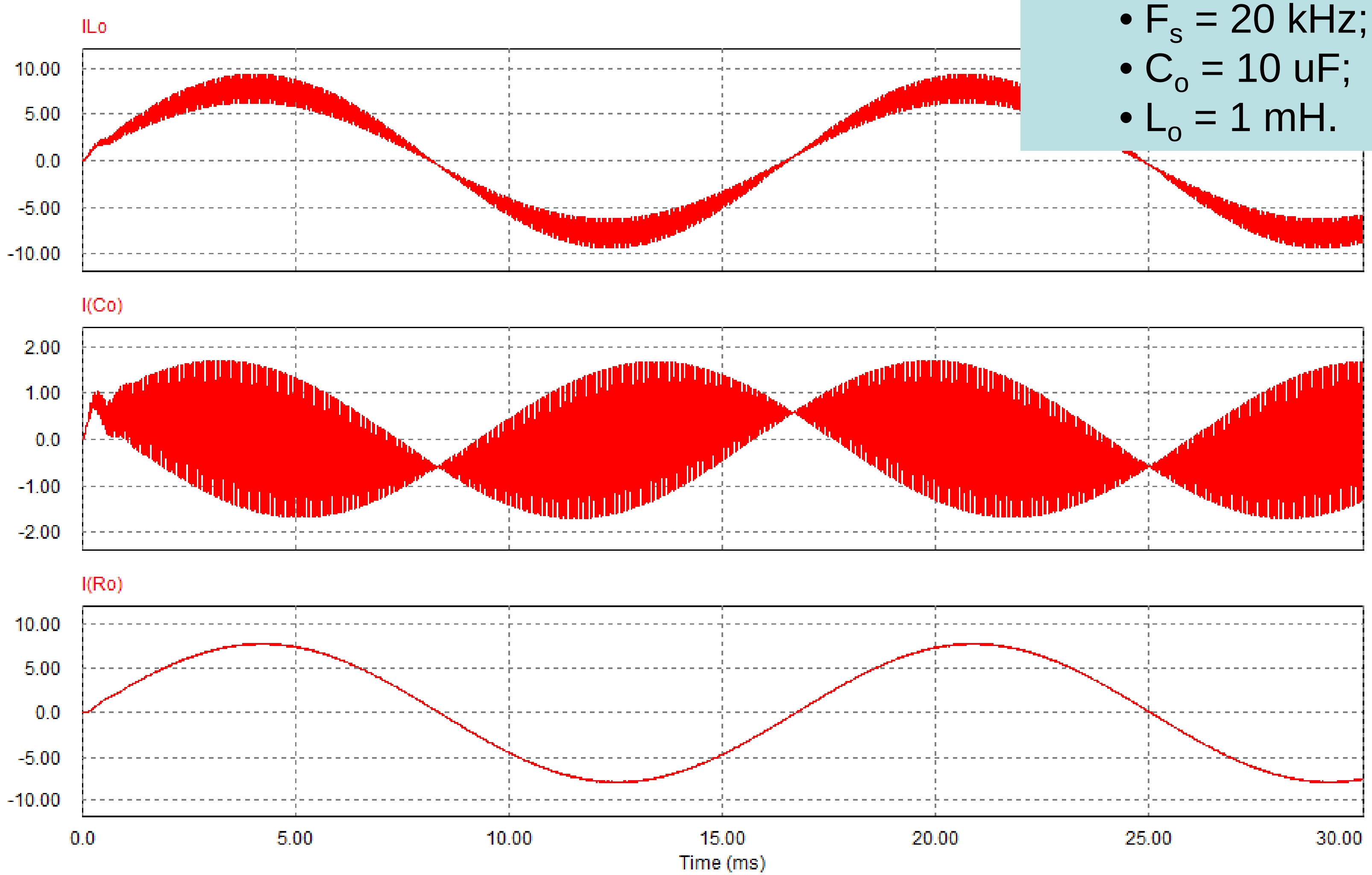
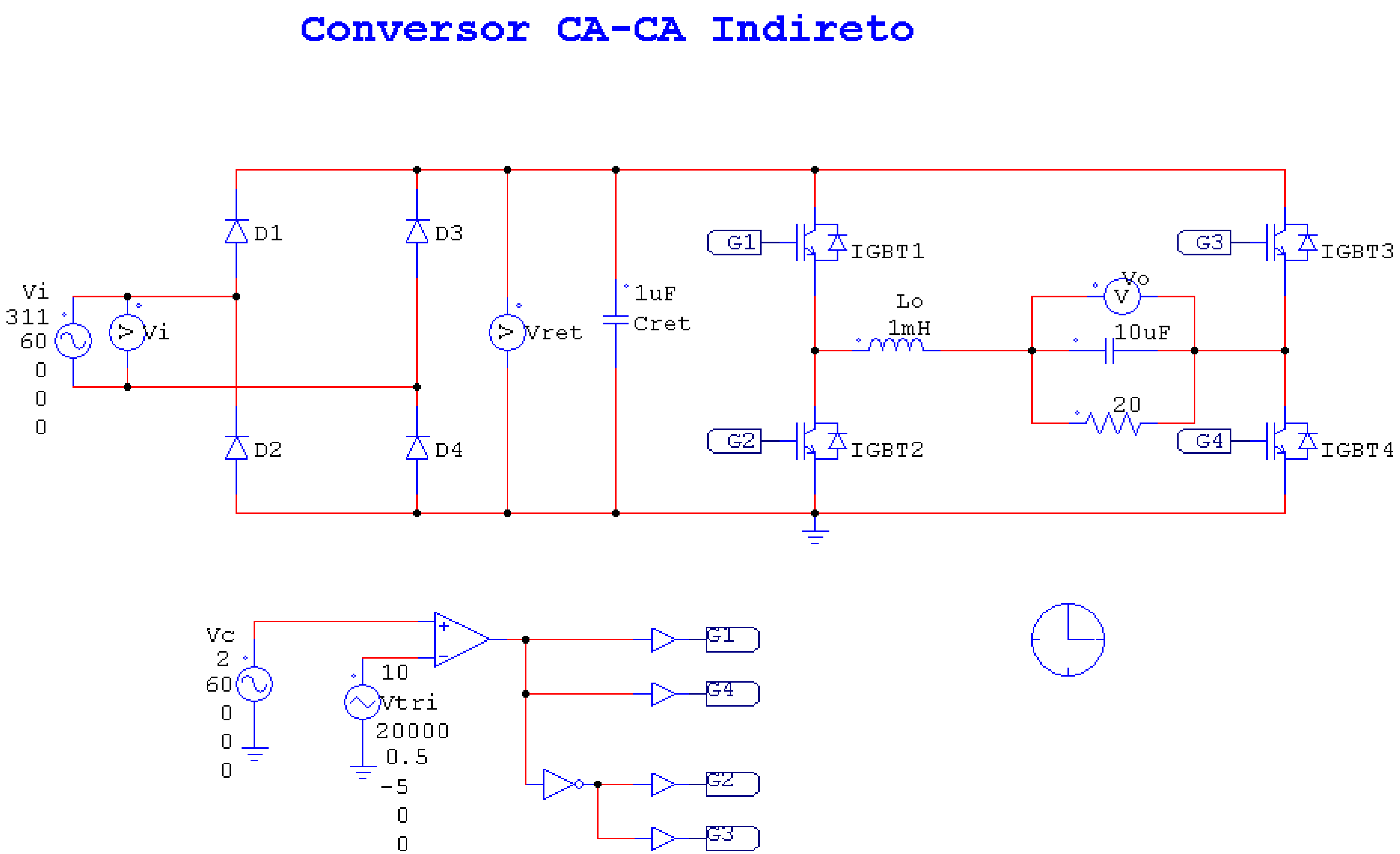


Dados da simulação:

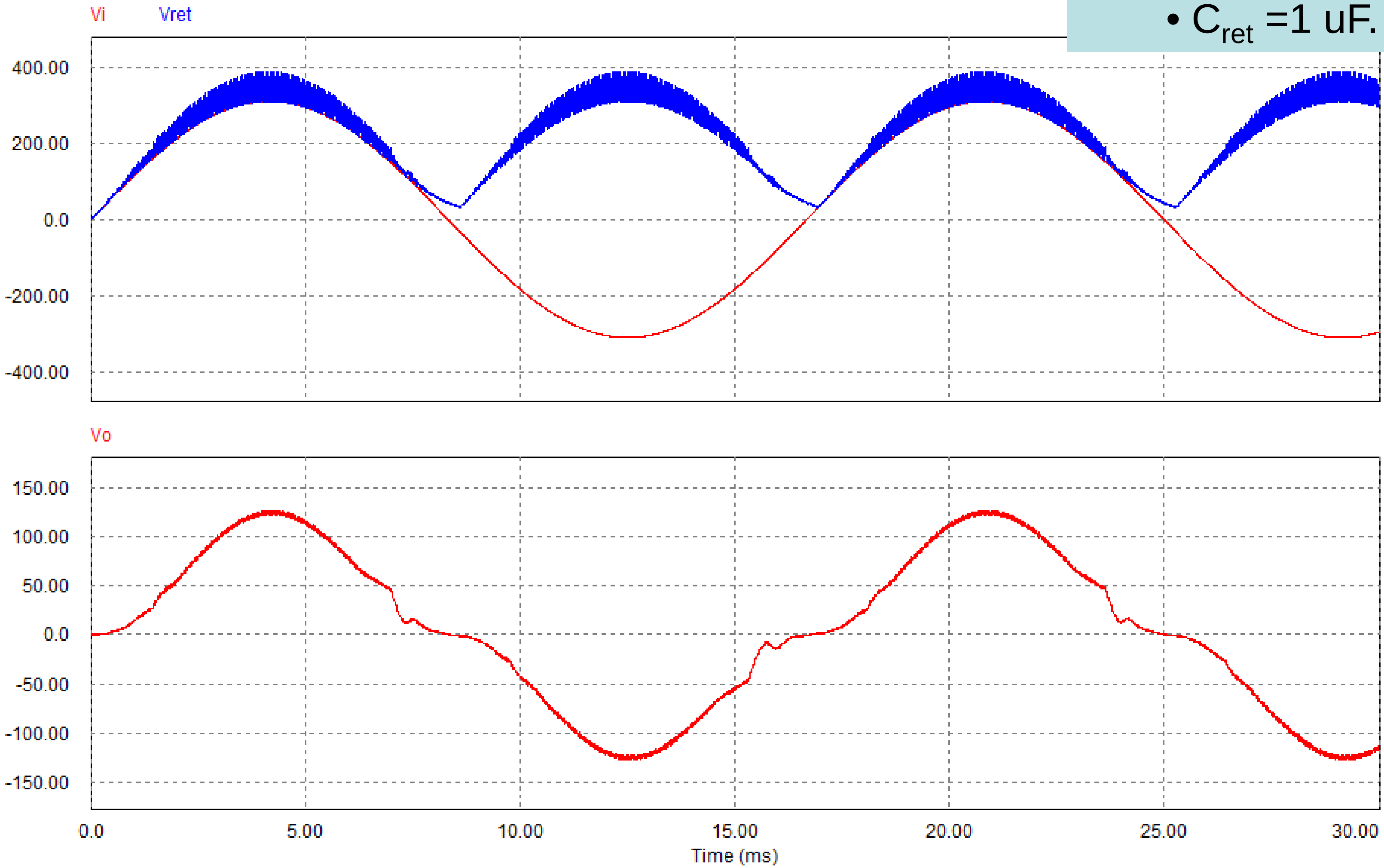
- F_s = 20 kHz;
- C_o = 10 uF;
- L_o = 1 mH.

Conversor CA-CA indireto



Conversor CA-CA indireto

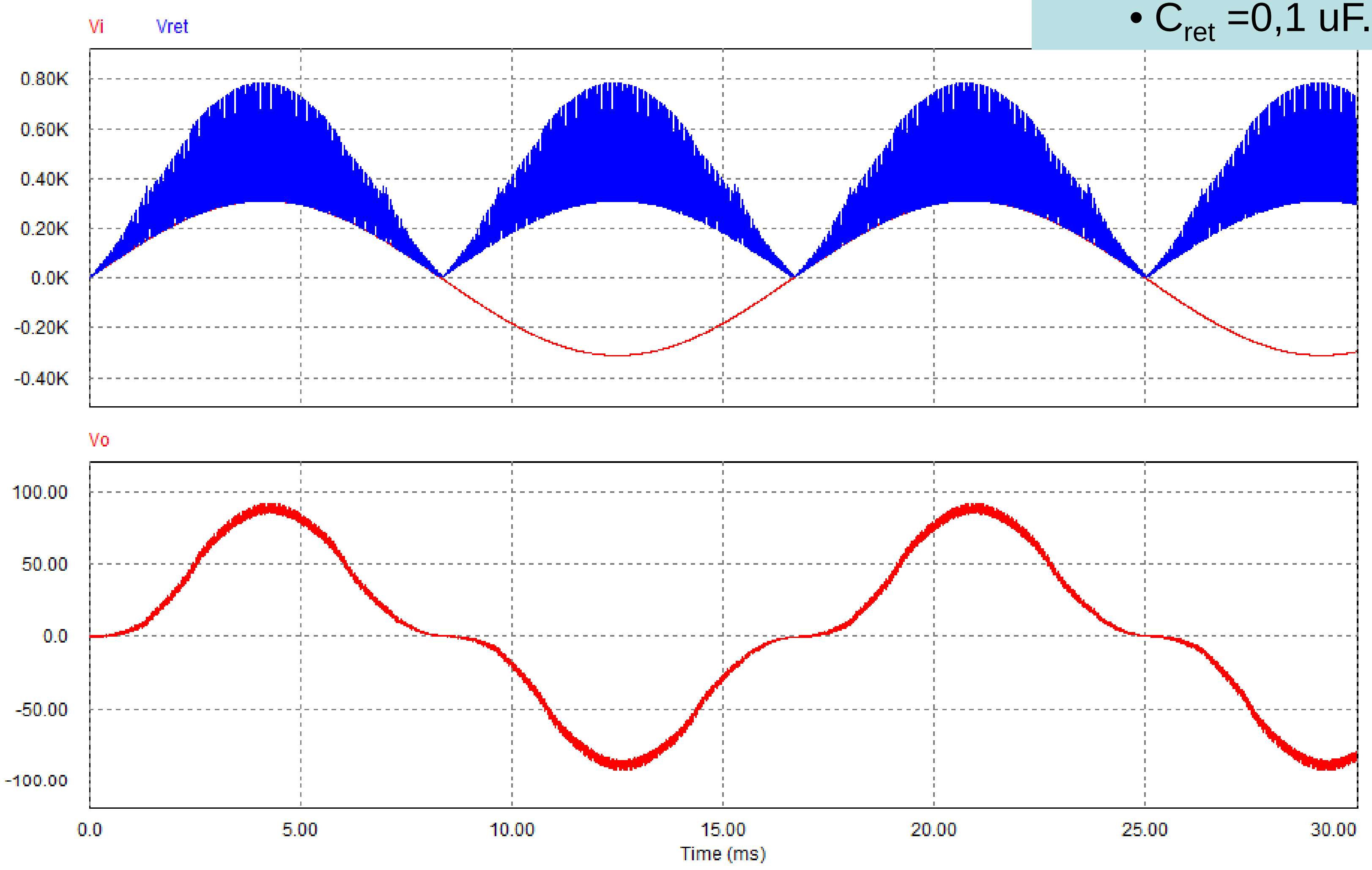
Dados da simulação:
- C_{ret} =1 uF.



Conversor CA-CA indireto

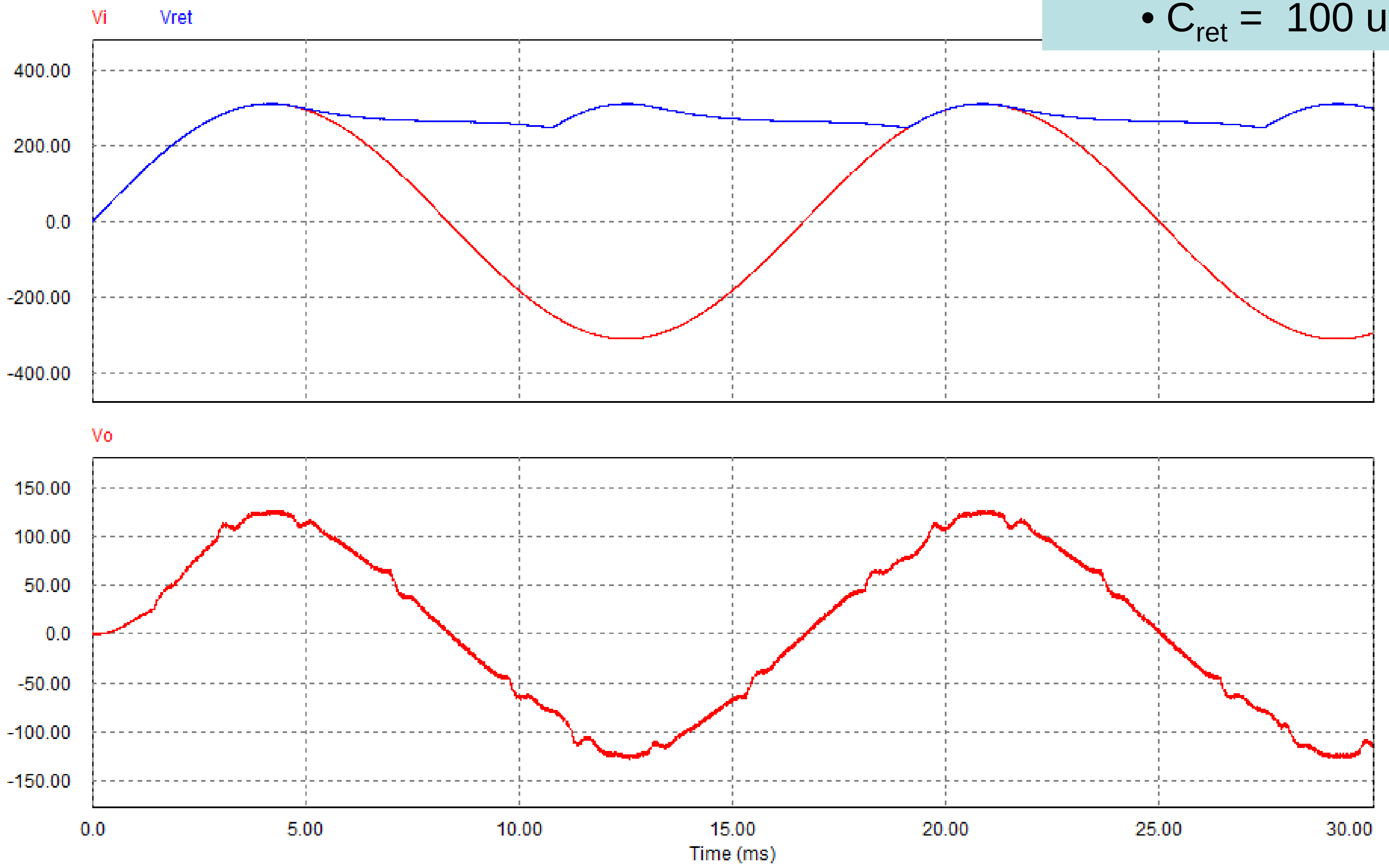
Dados da simulação:

- C_{ret} =0,1 uF.



Conversor CA-CA indireto

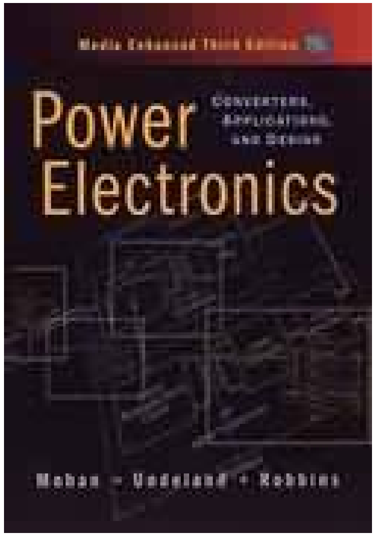
Dados da simulação:
- C_{ret} = 100 uF.

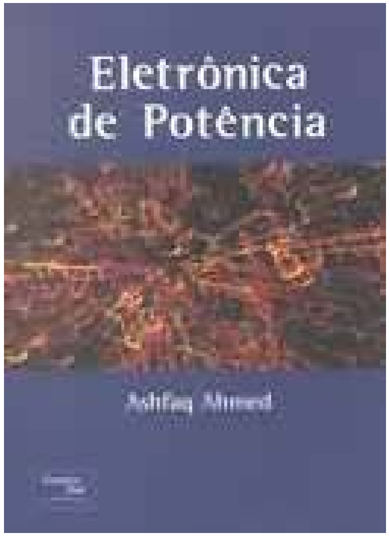


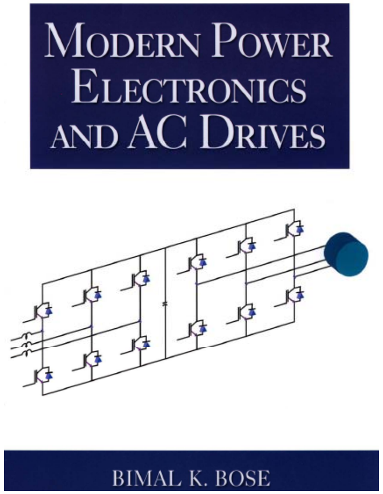
Próxima aula

Conversores CA-CA:

1. Simulação de conversores CA-CA.







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