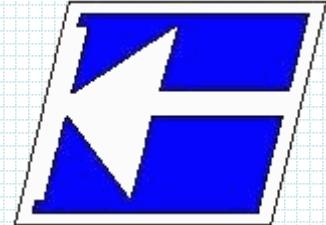


Instituto Federal de Educação, Ciência e Tecnologia de Santa Catarina
Departamento Acadêmico de Eletrônica
Curso de Graduação em Engenharia Eletrônica

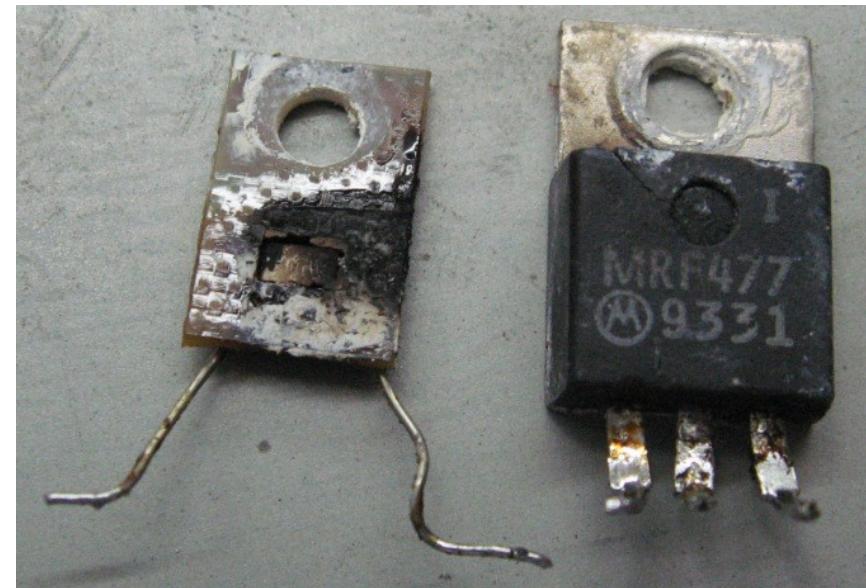


Metodologia de Projeto aplicada em conversores estáticos de potência

Prof. Joabel Moia.

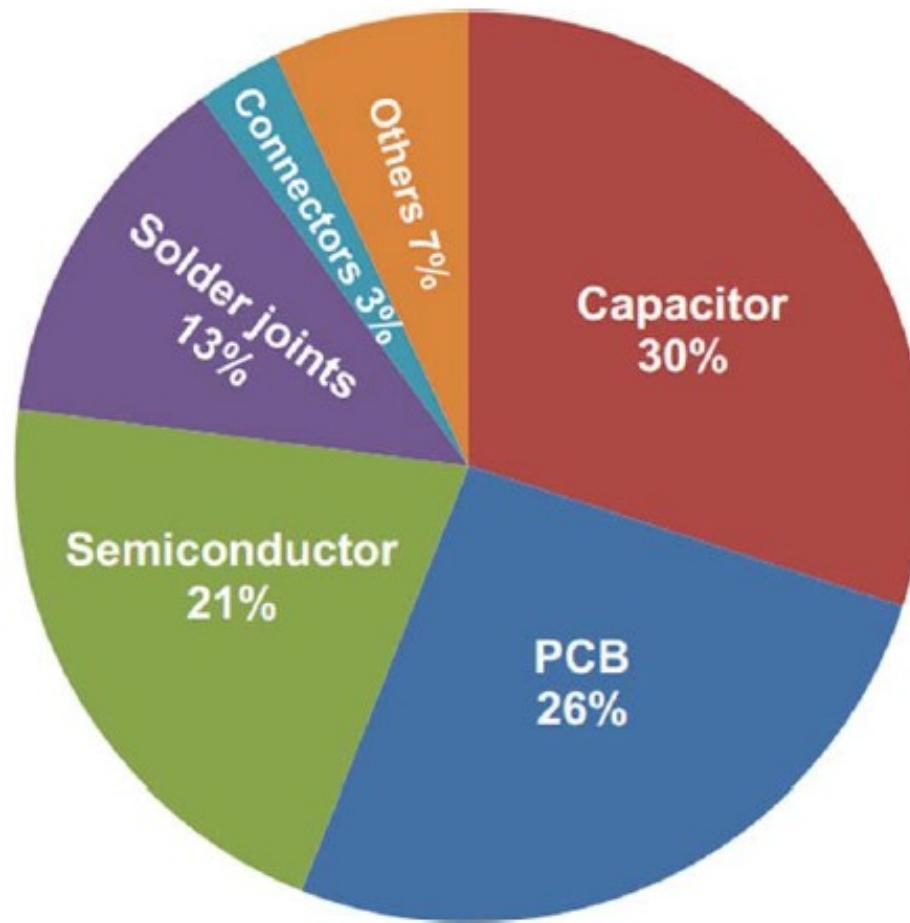
Florianópolis, abril de 2025.

Como projetar bem um conversor estático
com baixa taxa de falha e alta confiabilidade?



Metodologia de Projetos

Percentual de Falhas por componentes em conversores de potência



Fonte: QIAO, W.; LU, D. A survey on wind turbine condition monitoring and fault diagnosis — Part I

Pontos Importantes que devem ser observados no Projeto Conversores Estáticos de Potência:

- Considerar a Potência Máxima de Saída para o projeto;
- Analisar as condições de entrada:
 - Variação de Tensão e de Corrente
- Analisar as questões térmicas e calcular dissipador(es) apropriados:
 - Analisar o melhor lugar para deixar o dissipador para não afetar outros componentes do circuito;
 - Considerar que o conversor vai estar em um gabinete e em algumas vezes acondicionado em um lugar com temperatura alta;
 - Faixa de temperatura de operação;

Pontos Importantes que devem ser observados no Projeto Conversores Estáticos de Potência:

- Sempre fazer o projeto no pior caso:
 - Variação de tensão, frequência, potência e etc;
- Qualidade dos Componentes:
 - Adquirir componentes de fabricantes confiáveis;
- Desenhar o layout da Placa de Circuito Impresso de maneira adequada:
 - Levar também em consideração a Interferência Eletromagnética (EMI);
- Requisitos de isolamento entre entrada e saída
- Realizar testes adequados para a validação do conversor;

Pré-Escolha dos Semicondutores:

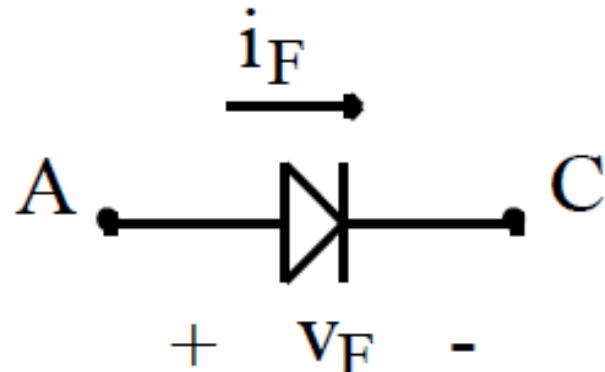
- A pré-escolha é feita com base no valor médio de corrente, corrente de pico e tensão máxima de bloqueio;
- Em seguida, com um número opções de modelos de semicondutores reduzidos, verifica-se as características Estáticas (R_{DS_ON} , V_F , V_{CE} , R_D , etc);
- Verifica-se também as características dinâmicas do semicondutor (t_r , t_f) e de recuperação reversa (Q_{rr} , t_{rr}), ou energia envolvidas nas comutações (*datasheet*) ;
- Por fim, realiza-se o cálculo térmico para escolher um dissipador, caso necessário, e analisar a viabilidade técnica do projeto, do ponto de vista de tamanho, peso, volume e etc;

Pré-Escolha dos Semicondutores:

- O cálculo de perdas podem ser validados por simulação numérica, pois pode apresentar modelos mais completos;
- Se for necessário, podem ser utilizados semicondutores em paralelo ou série, porém deve se tomar cuidado. Normalmente, prefere-se utilizar outras soluções por meio de topologias (circuitos elétricos);
- Alguns fabricantes de semicondutores oferecem a opção de livre de chumbo (*Lead Free*);
- A escolha do semicondutores (BJT, MOSFET, IGBT, etc) deve ser realizado em função do parâmetros elétricos, custo facilidade de aquisição e etc;

Diodo:

- Tensão máxima reversa;
- Cálculo da corrente média;
- Cálculo da corrente eficaz;
- Frequência de operação;
- Escolher um diodo disponível;
- Cálculo da corrente de pico;
- Calcular Perdas:
 - Condução
 - Comutação
 - Total
- Cálculo térmico



Diodo:

- ▶ **Diodos standard:** transição > 0,5μs
(baixa frequência)
- ▶ **Fast recovery** - transição < 250 ns
- ▶ **Soft-recovery** – transição
amortecida sem pico de tensão
(principalmente tecnologia Schottky)
- ▶ **ultrafast-recovery** transição < 100 ns
- ▶ **hyperfast-recovery** transição < 50 ns
- ▶ Zero recovery (Carbeto de silicio,
(SiC) – Silicon Carbide) transição em
tempo desprezível.

- **Fast:**
 - 50V/50ns – 5000V/5us;
- **Ultra Fast:**
 - 200V/25ns – 600V/40ns
- **Hyper Fast:**
 - 200V/30ns – 600V/16ns;
- **Zero-recovery:**
 - 100-200V/1ns

Diodo – exemplos 1N400X

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

PARAMETER	SYMBOL	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	UNIT
Maximum repetitive peak reverse voltage	V_{RRM}	50	100	200	400	600	800	1000	V
Maximum RMS voltage	V_{RMS}	35	70	140	280	420	560	700	V
Maximum DC blocking voltage	V_{DC}	50	100	200	400	600	800	1000	V
Maximum average forward rectified current 0.375" (9.5 mm) lead length at $T_A = 75^\circ\text{C}$	$I_{F(AV)}$				1.0				A
Peak forward surge current 8.3 ms single half sine-wave superimposed on rated load	I_{FSM}				30				A
Non-repetitive peak forward surge current square waveform $T_A = 25^\circ\text{C}$ (fig. 3)	$t_p = 1 \text{ ms}$ $t_p = 2 \text{ ms}$ $t_p = 5 \text{ ms}$	I_{FSM}			45				A
					35				
					30				
Maximum full load reverse current, full cycle average 0.375" (9.5 mm) lead length $T_L = 75^\circ\text{C}$	$I_{R(AV)}$				30				μA
Rating for fusing ($t < 8.3 \text{ ms}$)	I^2t (1)				3.7				A^2s
Operating junction and storage temperature range	T_J, T_{STG}				- 50 to + 150				$^\circ\text{C}$

PARAMETER	TEST CONDITIONS	SYMBOL	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	UNIT
Maximum instantaneous forward voltage	1.0 A	V_F				1.1				V
Maximum DC reverse current at rated DC blocking voltage	$T_A = 25^\circ\text{C}$	I_R				5.0				μA
	$T_A = 125^\circ\text{C}$					50				
Typical junction capacitance	4.0 V, 1 MHz	C_J				15				pF

Diodo – exemplos IDH10G65C5

Table 3 Maximum ratings

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Continuous forward current	I_F	—	—	10	A	$T_C < 140^\circ\text{C}$, D=1
Surge non-repetitive forward current, sine halfwave	$I_{F,SM}$	—	—	82		$T_C = 25^\circ\text{C}$, $t_p=10 \text{ ms}$
		—	—	71		$T_C = 150^\circ\text{C}$, $t_p=10 \text{ ms}$
Non-repetitive peak forward current	$I_{F,max}$	—	—	431	A^2s	$T_C = 25^\circ\text{C}$, $t_p=10 \mu\text{s}$
i ² t value	$\int i^2 dt$	—	—	34		$T_C = 25^\circ\text{C}$, $t_p=10 \text{ ms}$
		—	—	25		$T_C = 150^\circ\text{C}$, $t_p=10 \text{ ms}$
Repetitive peak reverse voltage	V_{RRM}	—	—	650	V	$T_j = 25^\circ\text{C}$
Diode dv/dt ruggedness	dv/dt	—	—	100	V/ns	$V_R=0.480 \text{ V}$
Power dissipation	P_{tot}	—	—	89	W	$T_C = 25^\circ\text{C}$
Operating and storage temperature	T_j, T_{stg}	-55	—	175	°C	
Mounting torque		—	—	70	Ncm	M3 screws

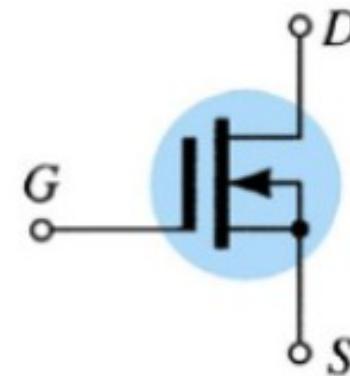
Table 4 Thermal characteristics TO-220-2

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction-case	R_{thJC}	—	1.0	1.7	K/W	
Thermal resistance, junction-ambient	R_{thJA}	—	—	62		leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	—	—	260	°C	1.6mm (0.063 in.) from case for 10 s

MOSFET:

MOSFET

- Tensão máxima no interruptor;
- Cálculo da corrente média;
- Cálculo da corrente eficaz;
- Escolher um interruptor disponível;
- Observar a R_{DSon} e os tempos de operação;
- Cálculo da corrente de pico;
- Calcular Perdas:
 - Condução
 - Comutação
 - Total
- Cálculo térmico



MOSFET:



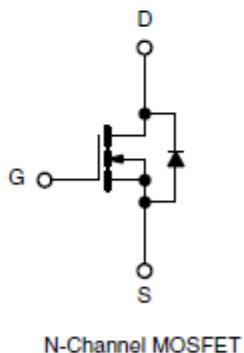
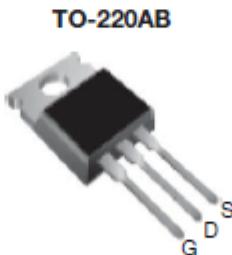
www.vishay.com

IRF840, SiHF840

Vishay Siliconix

Power MOSFET

PRODUCT SUMMARY	
V_{DS} (V)	500
$R_{DS(on)}$ (Ω)	$V_{GS} = 10$ V 0.85
Q_g max. (nC)	63
Q_{gs} (nC)	9.3
Q_{gd} (nC)	32
Configuration	Single



FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



Available
RoHS*

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non-RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details.

DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

MOSFET: IRF840

ORDERING INFORMATION				
Package		TO-220AB		
Lead (Pb)-free		IRF840PbF		
		SIHF840-E3		
SnPb		IRF840		
		SIHF840		
ABSOLUTE MAXIMUM RATINGS ($T_C = 25^\circ\text{C}$, unless otherwise noted)				
PARAMETER		SYMBOL	LIMIT	UNIT
Drain-Source Voltage		V_{DS}	500	V
Gate-Source Voltage		V_{GS}	± 20	V
Continuous Drain Current	V_{GS} at 10 V	$T_C = 25^\circ\text{C}$	I_D	A
		$T_C = 100^\circ\text{C}$	5.1	
Pulsed Drain Current ^a		I_{DM}	32	
Linear Derating Factor			1.0	W/ $^\circ\text{C}$
Single Pulse Avalanche Energy ^b		E_{AS}	510	mJ
Repetitive Avalanche Current ^a		I_{AR}	8.0	A
Repetitive Avalanche Energy ^a		E_{AR}	13	mJ
Maximum Power Dissipation	$T_C = 25^\circ\text{C}$	P_D	125	W
Peak Diode Recovery dV/dt ^c		dV/dt	3.5	V/ns
Operating Junction and Storage Temperature Range		T_J, T_{stg}	-55 to +150	$^\circ\text{C}$
Soldering Recommendations (Peak temperature) ^d	for 10 s		300	
Mounting Torque	6-32 or M3 screw		10	lbf · in
			1.1	N · m

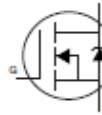
Notes:

MOSFET: IRF840

SPECIFICATIONS ($T_J = 25^\circ\text{C}$, unless otherwise noted)								
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT	
Static								
Drain-Source Breakdown Voltage	V_{DS}	$V_{GS} = 0 \text{ V}$, $I_D = 250 \mu\text{A}$		500	-	-	V	
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25°C , $I_D = 1 \text{ mA}$		-	0.78	-	$^\circ\text{C}$	
Gate-Source Threshold Voltage	$V_{GS(\text{th})}$	$V_{DS} = V_{GS}$, $I_D = 250 \mu\text{A}$		2.0	-	4.0	V	
Gate-Source Leakage	I_{GSS}	$V_{GS} = \pm 20 \text{ V}$		-	-	± 100	nA	
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 500 \text{ V}$, $V_{GS} = 0 \text{ V}$		-	-	25	μA	
		$V_{DS} = 400 \text{ V}$, $V_{GS} = 0 \text{ V}$, $T_J = 125^\circ\text{C}$		-	-	250		
Drain-Source On-State Resistance	$R_{DS(\text{on})}$	$V_{GS} = 10 \text{ V}$	$I_D = 4.8 \text{ A}^b$	-	-	0.85	Ω	
Forward Transconductance	g_{fs}	$V_{DS} = 50 \text{ V}$, $I_D = 4.8 \text{ A}^b$		4.9	-	-	S	
Dynamic								
Input Capacitance	C_{iss}	$V_{GS} = 0 \text{ V}$, $V_{DS} = 25 \text{ V}$, $f = 1.0 \text{ MHz}$, see fig. 5		-	1300	-	pF	
Output Capacitance	C_{oss}			-	310	-		
Reverse Transfer Capacitance	C_{rss}			-	120	-		
Total Gate Charge	Q_g	$V_{GS} = 10 \text{ V}$	$I_D = 8 \text{ A}$, $V_{DS} = 400 \text{ V}$, see fig. 6 and 13 ^b	-	-	63	nC	
Gate-Source Charge	Q_{gs}			-	-	9.3		
Gate-Drain Charge	Q_{gd}			-	-	32		
Turn-On Delay Time	$t_{d(on)}$			-	14	-		
Rise Time	t_r	$V_{DD} = 250 \text{ V}$, $I_D = 8 \text{ A}$ $R_g = 9.1 \Omega$, $R_D = 31 \Omega$, see fig. 10 ^b		-	23	-	ns	
Turn-Off Delay Time	$t_{d(off)}$			-	49	-		
Fall Time	t_f			-	20	-		
Internal Drain Inductance	L_D	Between lead, 6 mm (0.25") from package and center of die contact		-	4.5	-	nH	
Internal Source Inductance	L_S			-	7.5	-		
Gate Input Resistance	R_g	$f = 1 \text{ MHz}$, open drain		0.6	-	2.8	Ω	

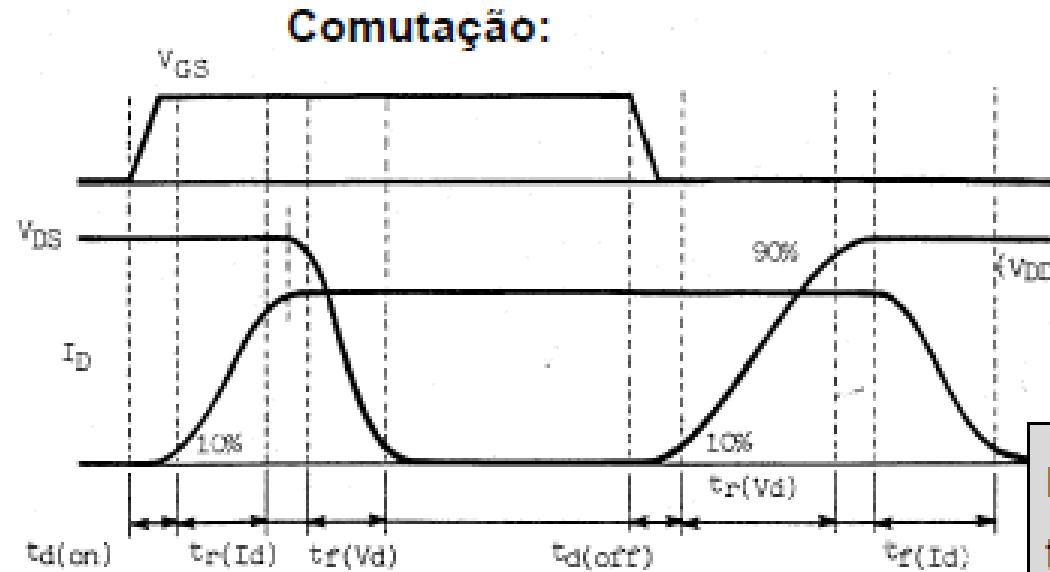


MOSFET: IRF840

Drain-Source Body Diode Characteristics								
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode		-	-	8.0	A	
Pulsed Diode Forward Current ^a	I_{SM}			-	-	32		
Body Diode Voltage	V_{SD}	$T_J = 25 \text{ }^\circ\text{C}, I_S = 8 \text{ A}, V_{GS} = 0 \text{ V}^b$		-	-	2.0	V	
Body Diode Reverse Recovery Time	t_{rr}	$T_J = 25 \text{ }^\circ\text{C}, I_F = 8 \text{ A}, dI/dt = 100 \text{ A}/\mu\text{s}^b$		-	460	970	ns	
Body Diode Reverse Recovery Charge	Q_{rr}			-	4.2	8.9	μC	
Forward Turn-On Time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)						

MOSFET: IRF840

Dimensionamento do interruptores



P_{com} = Perdas de comutação. [W]

t_{on} = Tempo de entrada em condução

V_{RM} = Tensão reversa

f = frequência de comutação

$$P_{\text{com}} = \frac{f}{2} (t_{\text{on}} + t_{\text{off}}) i_d \cdot V_{ds}$$

MOSFET: Safe Operating Area (SOA)

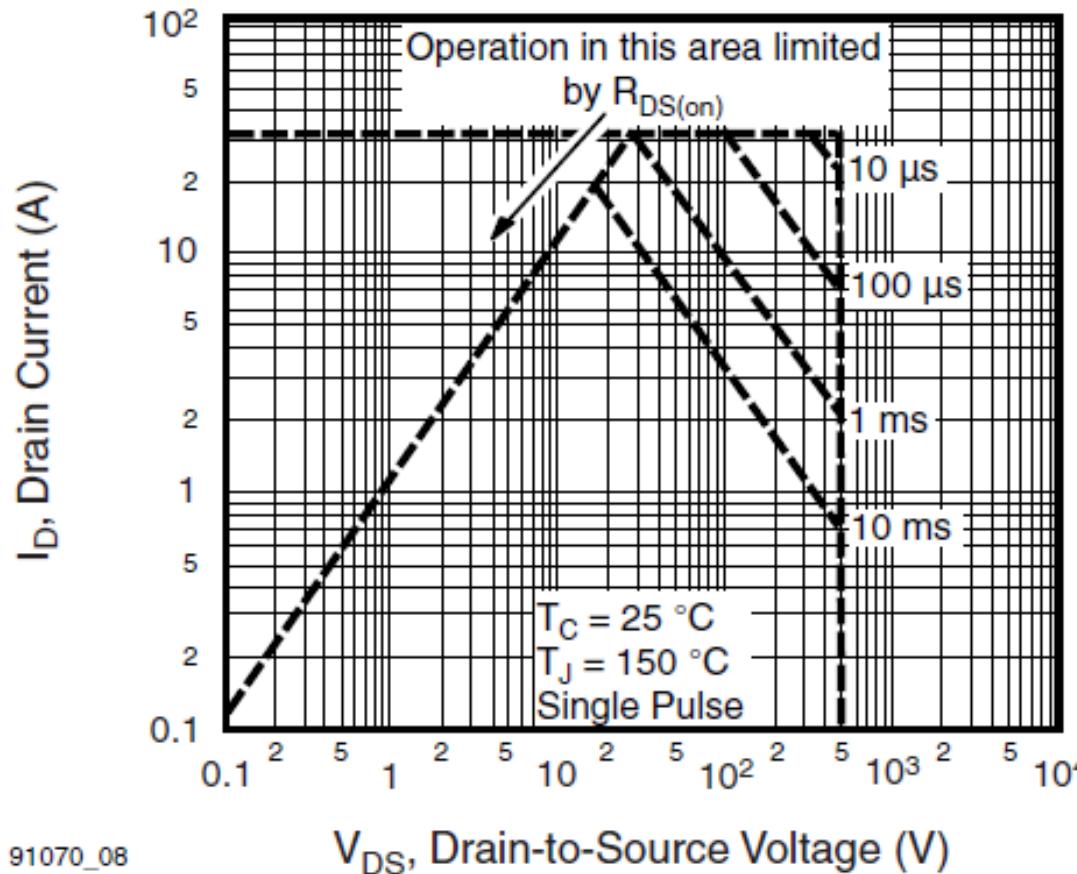
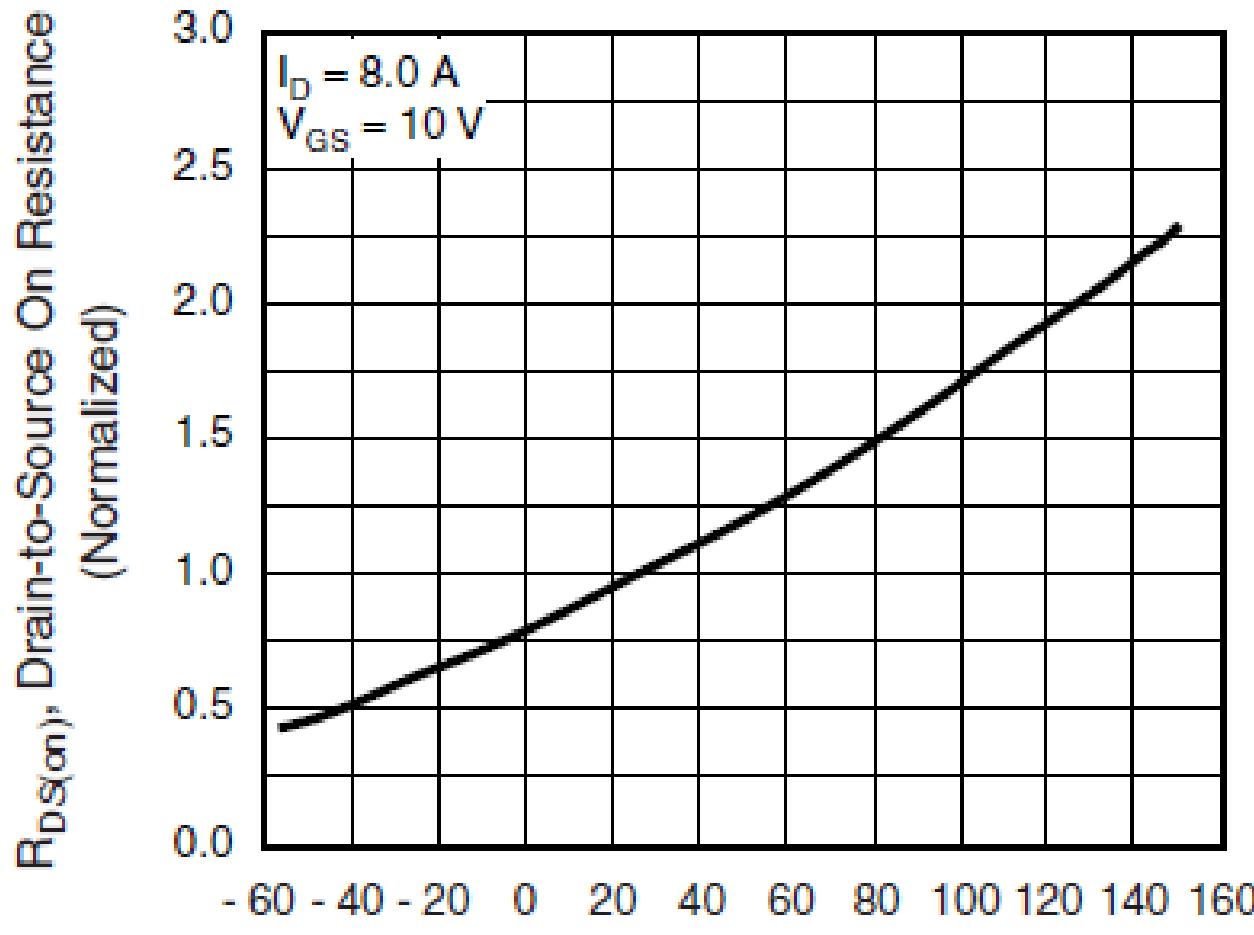


Fig. 8 - Maximum Safe Operating Area

Metodologia de Projetos



$$P_{con} = \frac{t_{on}}{T} i_d^2 r_{ds}$$

91070_04

T_J , Junction Temperature (°C)

P_{con} = Perdas em condução. [W]
 t_{on} = tempo em condução. [s]
 i_d = corrente em condução. [A]
 r_{ds} = resistência em condução. [Ω]
 T = Período de chaveamento

MOSFET:

$$P_{mosfet} = P_{com} + P_{con}$$

P_{mosfet} = Perdas totais no mosfet. [W]

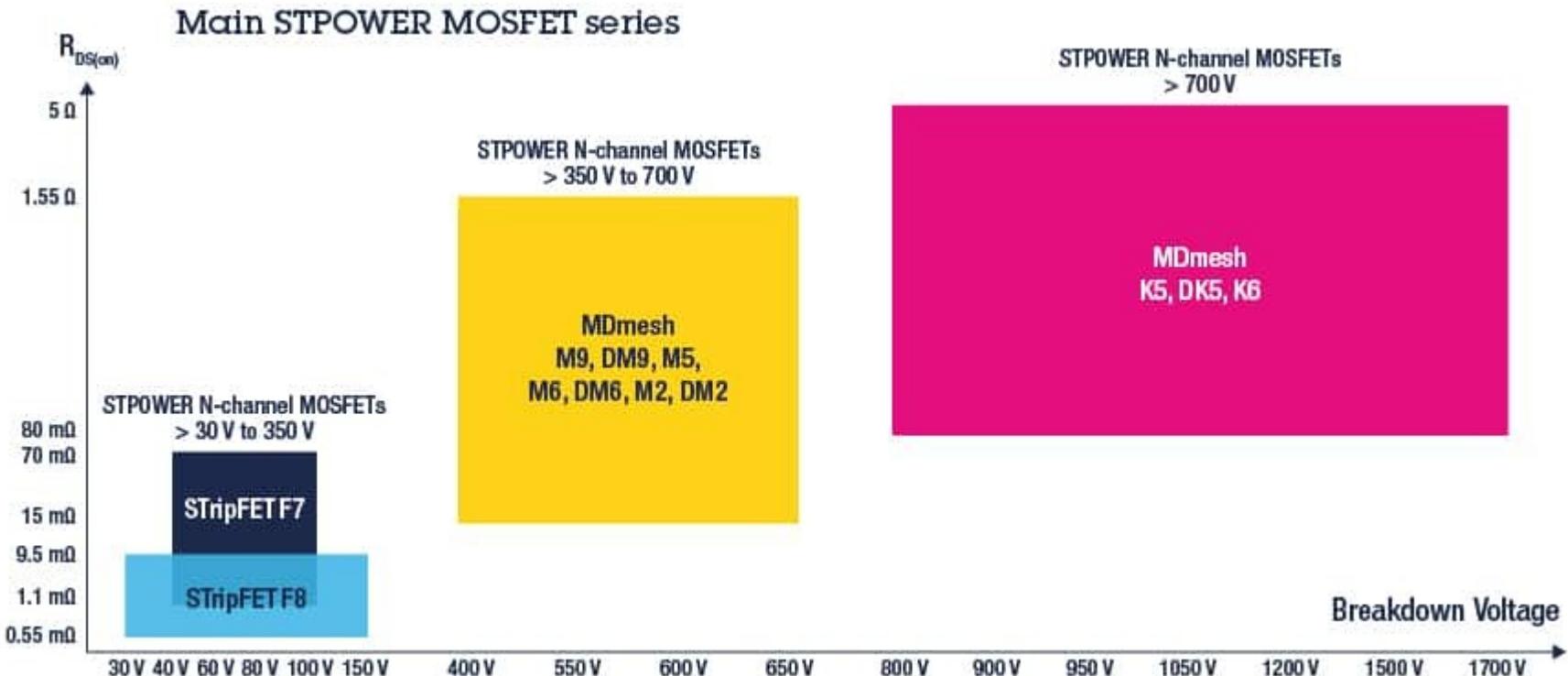
P_{com} = Perdas de comutação. [W]

P_{con} = Perdas em condução. [W]

Considerações importantes para MOSFETs:

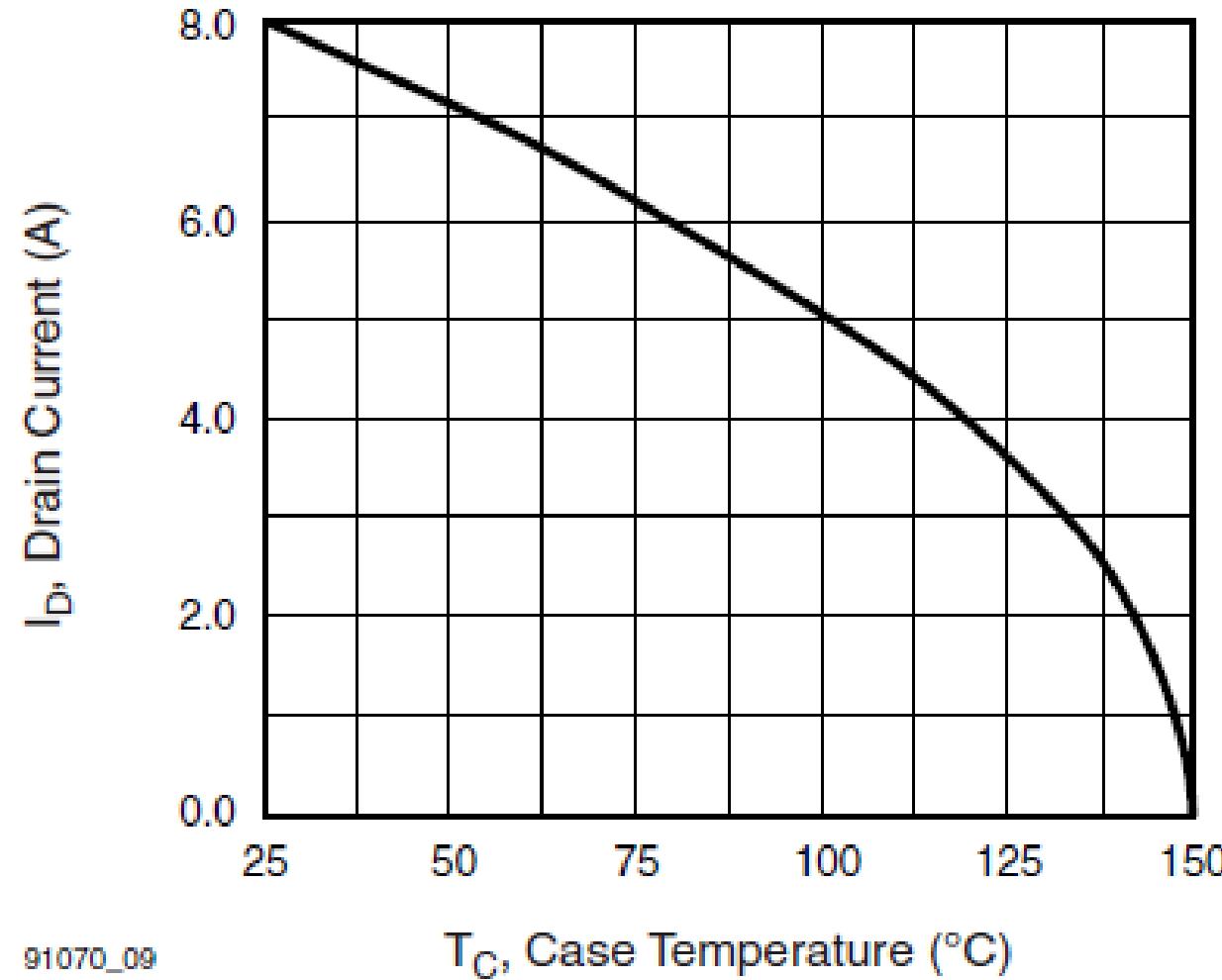
- Apresentam diodo intrínseco entre os terminais Source e Drain.
- Com terminal de gate aberto é normalmente fechado entre Drain-Source.

Metodologia de Projetos

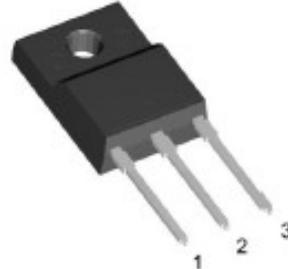


Fonte: http://www.st.com/content/st_com/en/products/power-transistors/power-mosfets.html

MOSFET:



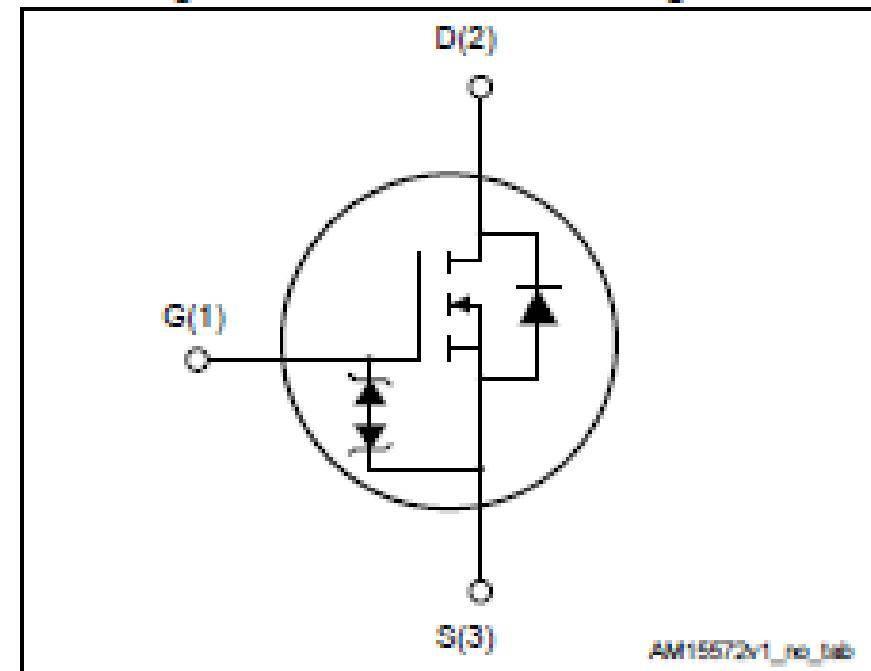
Diodos Zener Interno:



TO-220FP wide creepage

Figure 1: Internal schematic diagram

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 25	V
I_D	Drain current (continuous) at $T_c = 25^\circ\text{C}$	18 ⁽¹⁾	A
I_D	Drain current (continuous) at $T_c = 100^\circ\text{C}$	12 ⁽¹⁾	A
I_{DM} ⁽²⁾	Drain current (pulsed)	72 ⁽¹⁾	A
P_{TOT}	Total dissipation at $T_c = 25^\circ\text{C}$	30	W
dV/dt ⁽³⁾	Peak diode recovery voltage slope	15	V/ns
dV/dt ⁽⁴⁾	MOSFET dV/dt ruggedness	50	V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1\text{ s}$; $T_C = 25^\circ\text{C}$)	2500	V
$T_{Storage}$	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range		



STFH24N60M2

N-channel 600 V, 0.168 Ω typ., 18 A MDmesh™ M2
Power MOSFET in a TO-220FP wide creepage package

Principais Fabricantes de Semicondutores de Potência:

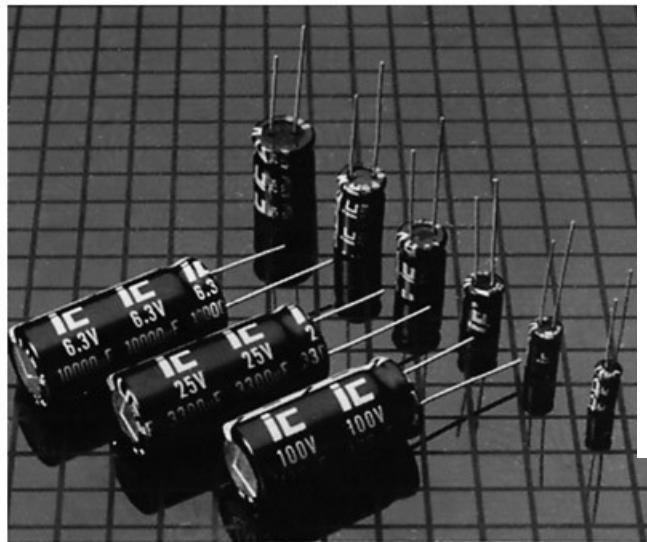
- Powerex;
- Infineon Technologies;
- ST Microelectronics;
- Ixys Corporation;
- Semikron;
- Fairchild;
- On Semiconductor;
- Microsemi;
- Vishay;
- Intersil;
- Cree Inc;
- International Rectifier (Infineon/Vishay);



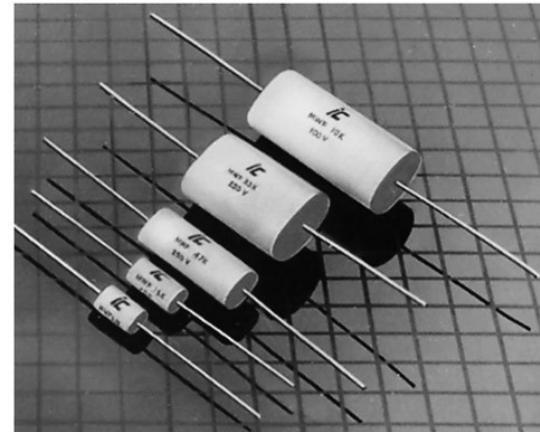
Principais Fabricantes de Semicondutores no Brasil:

- HT Micron (São Leopoldo/RS):
 - IoT Devices;
 - Memórias: DRAM, eMCP, eMMC
- Ceitec/MCTI (Porto Alegre/RS):
 - Microfabricação em wafers de silício, quartzo, carbeto de silício (SiC) e nitreto de gálio (GaN)
- Unitec (Ribeirão das Neves/MG):
 - IoT devices;
 - Smart Parking Systems;
 - Wearable Electronics;

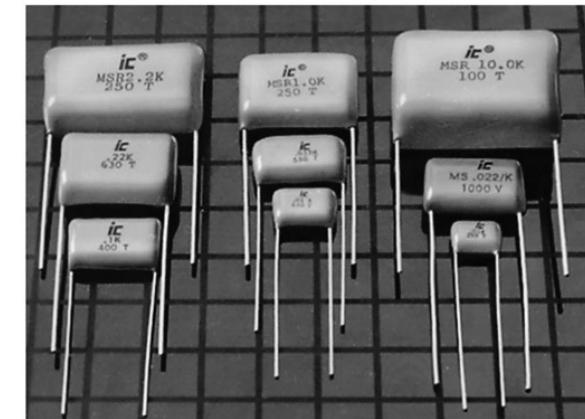
Capacitores:



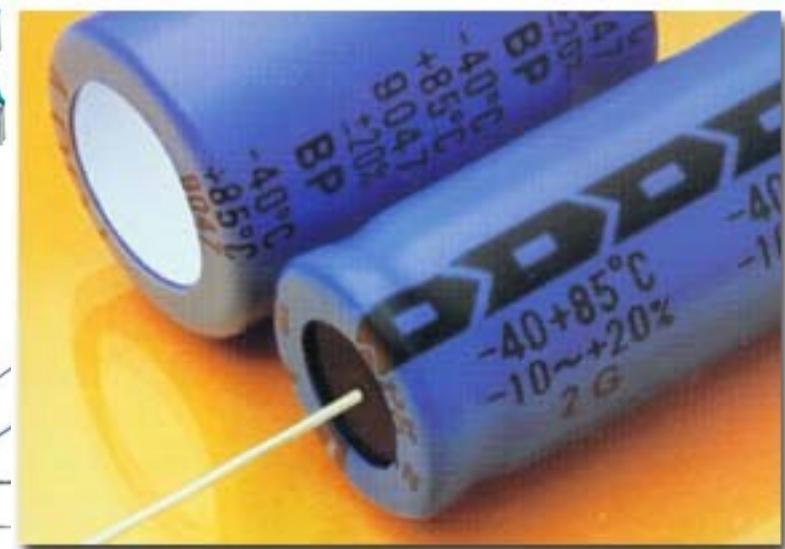
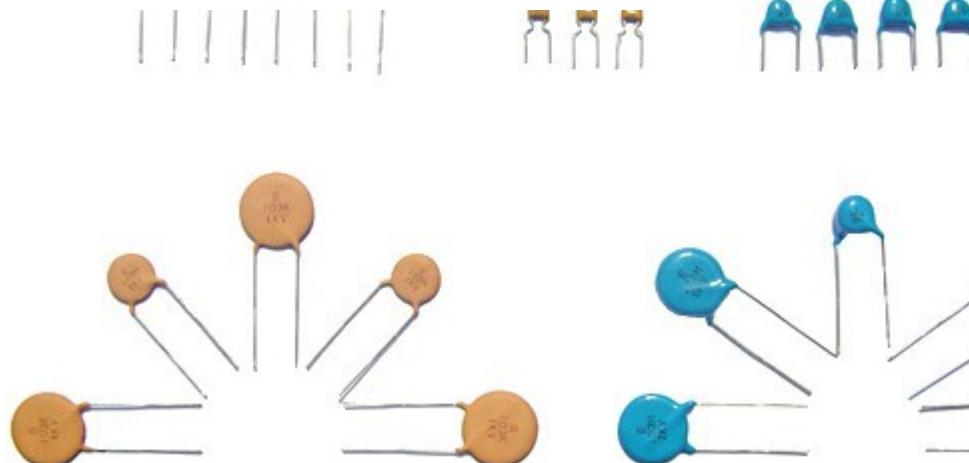
(a)



(a)



(b)



Capacitores:



Modelo equivalente do capacitor

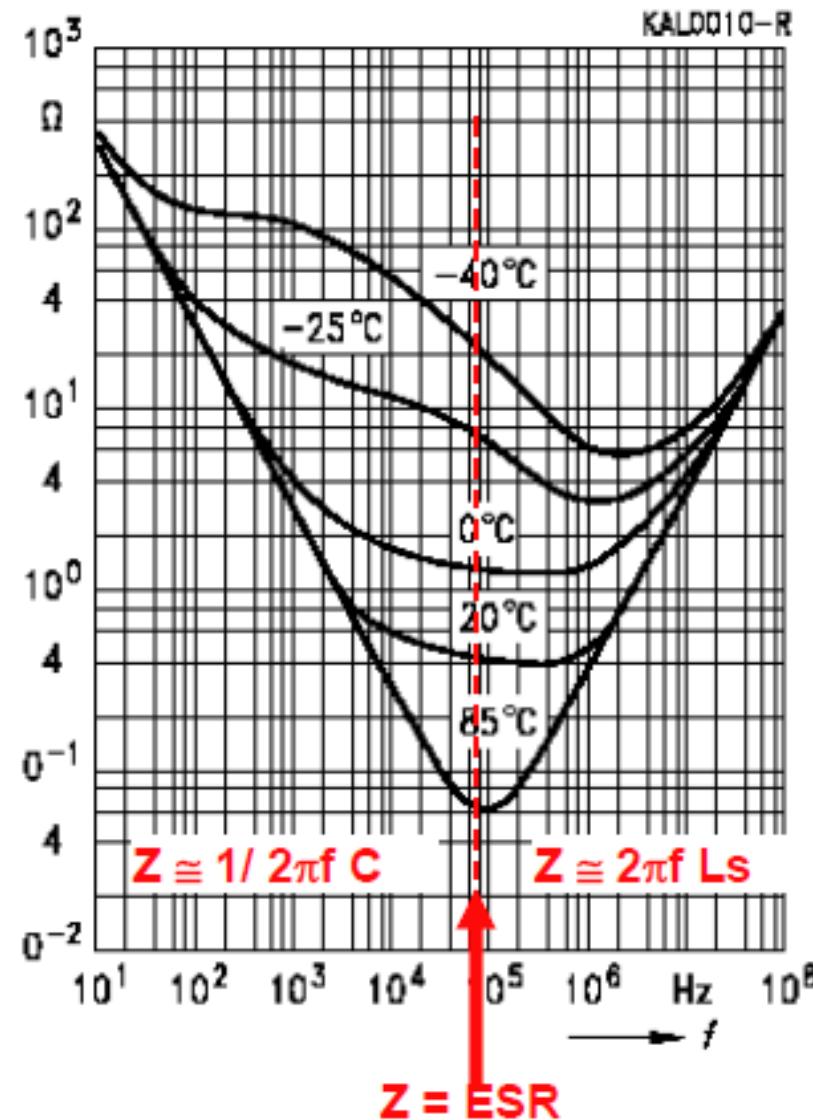
Onde:

- C = Capacitância;
- RSE = Resistência série equivalente;
- LSE = Indutância série equivalente.

Perdas devido à RSE:

$$P = RSE \cdot I_{ef}^2$$

Curva de Impedância do Capacitor: ($Z \times$ Frequência):



Tipos de capacitores

- Eletrolíticos de Alumínio;
- Cerâmicos Multicamada;
- Filme Metalizado;
- Eletrolíticos de Tântalo;
- Capacitores de Potência;
- Ultra Capacitores;

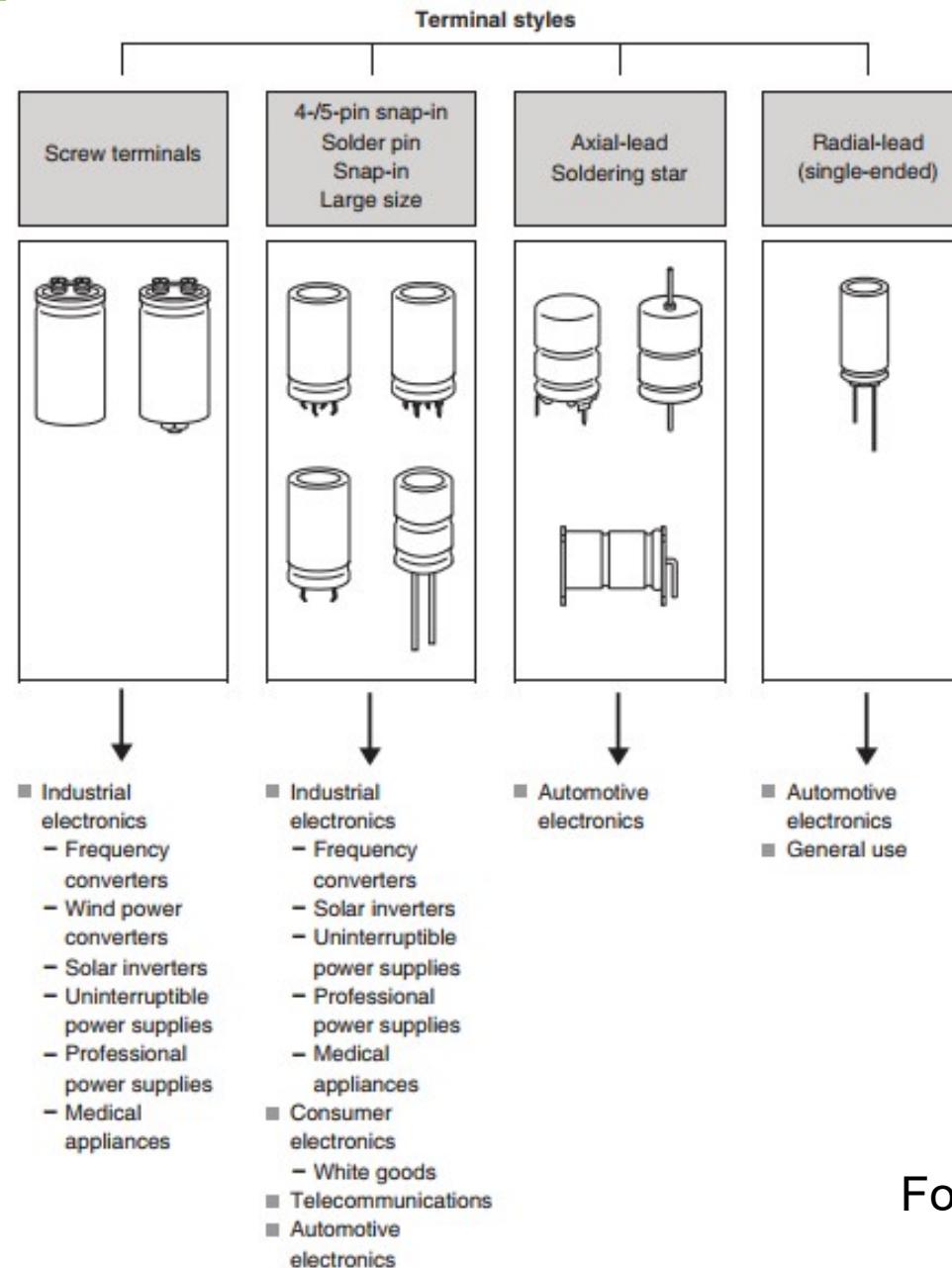
Mais usados em eletrônica de potência:

- **Em filtros de conversores CC-CC e CA-CC** – São empregados capacitores eletrolíticos (maior densidade de potência);
- **Circuitos de auxiliares de comutação ou grampeamento:** Capacitores de polipropileno ou similares.
- **Circuitos de controle:** Cerâmicos (boa resposta em alta frequência)

Tecnologias de capacitores:

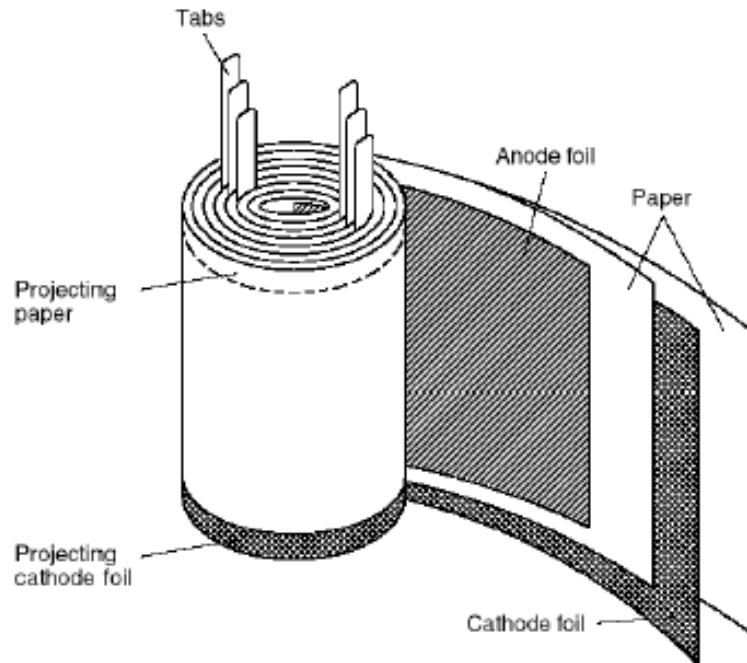
- Filtro do retificador de entrada – São empregados capacitores Eletrolíticos de alta tensão e grandes capacitâncias;
- Filtro de saída dos conversores – Empregam-se capacitores Eletrolíticos alumínio com baixa RSE;
- Circuitos de grampeamento (snubber) – São utilizados capacitores com dielétricos de polipropileno para regime intermitente de funcionamento.

Metodologia de Projetos



Fonte: EPCOS

Capacitores Eletrolítico



- Lâmina de alumínio recoberta por uma camada de óxido (dielétrico) e uma tira de papel impregnado com um líquido condutor eletrólito, sobreposto por uma outra lâmina de alumínio em contato com o papel.

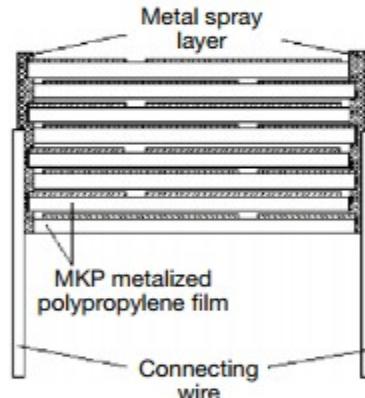
Capacitores de Filme - Polipropileno



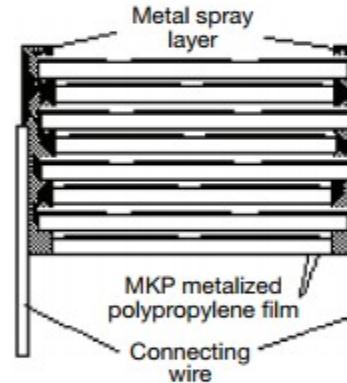
www.vishay.com

General Technical Information

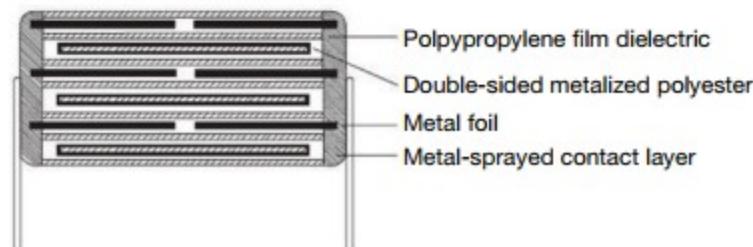
Vishay Roederstein



MKP385 (1600 V to 2000 V)
Extended metallized film with internal series connections
(3 sections) design



MKP385 (2500 V) Extended metallized film with
internal series connections (4 sections) design



Capacitores Eletrolítico: Marcação e Tolerância



EPCOS

LL
B43511-A9108-M

1000 μ F (M)

400 V-

40/085/56

11.12

Manufacturer (company logo)

Grade (only on LL grade capacitors)

Part number (ordering code)

Rated capacitance, tolerance (in coded form)

Rated voltage, climatic category

(to IEC or coded as explained below)

Month and year of production

KAL1399-7-E

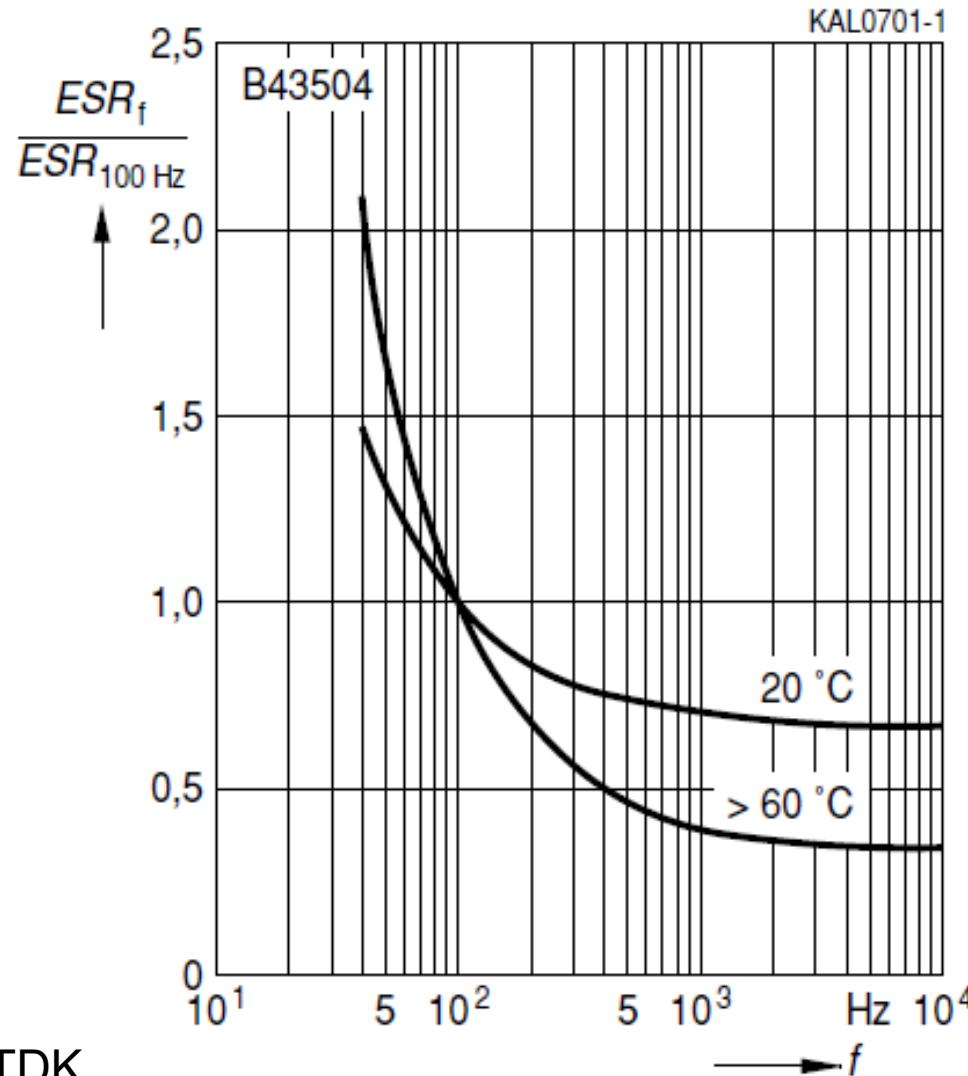
Figure

Marking example

Capacitance tolerances are coded to IEC 60062 using the codes shown below:

Code letter	Capacitance tolerance	Code letter	Capacitance tolerance
A	Tolerances to which no other code applies	R	-20%/+30%
K	$\pm 10\%$	S	-20%/+50%
M	$\pm 20\%$	T	-10%/+50%
N	$\pm 30\%$	V	-10%/+100%
Q	-10%/+30%	Y	0%/+50%
		Z	-20%/+80%

Capacitores Eletrolíticos: Variação da RSE com a frequência



B34504 EPCOS/TDK

Capacitores Eletrolíticos: Dados

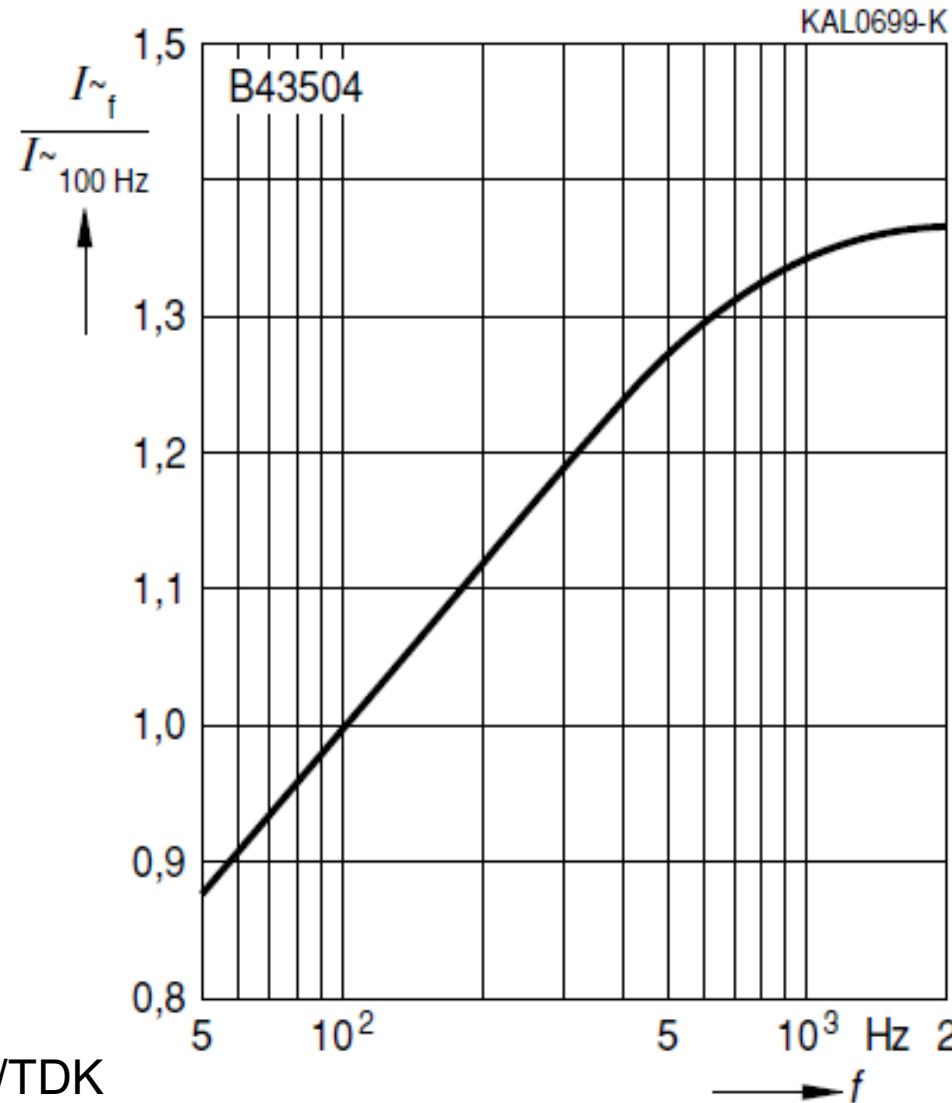
U_R VDC	C_R 100 Hz 20 °C μF	Case dimensions $d \times l$ mm	ESR_{typ} 100 Hz 20 °C mΩ	Z_{\max} 10 kHz 20 °C mΩ	$I_{\sim\max}$ 100 Hz 40 °C A	$I_{\sim\max}$ 100 Hz 85 °C A	$I_{\sim R}^1)$ 100 Hz 105 °C A
200	220	22 × 25	580	700	2,6	1,7	0,84
	270	22 × 25	480	570	2,8	1,9	0,93
	330	22 × 30	390	470	3,3	2,2	1,1
	390	22 × 30	330	400	3,6	2,4	1,2
	470	22 × 35	280	330	4,2	2,8	1,4
	470	30 × 25	280	330	4,5	3,0	1,5
	560	25 × 35	230	280	5,0	3,4	1,6
	680	25 × 40	190	230	5,8	3,9	1,9
	680	35 × 25	190	230	6,0	4,0	2,0
	820	25 × 45	160	190	6,6	4,5	2,2
	820	35 × 30	160	190	6,9	4,7	2,3
	1 000	30 × 35	130	160	7,3	4,9	2,4
	1 200	30 × 40	110	130	8,4	5,6	2,7
	1 500	35 × 40	90	110	10	6,9	3,4
	1 800	35 × 45	80	90	12	7,9	3,9
	2 200	35 × 50	60	70	14	9,1	4,4

B34504 EPCOS/TDK

Capacitores Eletrolíticos: Dados

U_R VDC	C_R 100 Hz 20 °C μF	Case dimensions $d \times l$ mm	ESR_{typ} 100 Hz 20 °C	Z_{\max} 10 kHz 20 °C	$I_{\sim\max}$ 100 Hz 40 °C	$I_{\sim\max}$ 100 Hz 85 °C	$I_{\sim R}^{1)}$ 100 Hz 105 °C	Ordering code ²⁾
250	220	22 × 30	580	700	2,7	1,8	0,89	B43504A2227M000
	270	22 × 35	480	570	3,2	2,2	1,1	B43504A2277M000
	330	22 × 40	390	470	3,7	2,5	1,2	B43504B2337M000
	330	25 × 30	390	470	3,6	2,4	1,2	B43504C2337M000
	390	25 × 35	330	400	4,2	2,8	1,4	B43504A2397M000
	470	22 × 50	280	330	4,9	3,3	1,6	B43504A2477M000
	470	30 × 30	280	330	4,7	3,2	1,6	B43504B2477M000
	560	25 × 45	230	280	5,5	3,7	1,8	B43504A2567M000
	680	25 × 50	190	230	6,3	4,2	2,1	B43504A2687M000
	680	30 × 40	190	230	6,3	4,2	2,1	B43504B2687M000
	820	30 × 45	160	190	7,2	4,9	2,4	B43504B2827M000
	1 000	35 × 40	130	160	8,4	5,7	2,8	B43504A2108M000
	1 200	35 × 45	110	130	9,6	6,5	3,2	B43504A2128M000

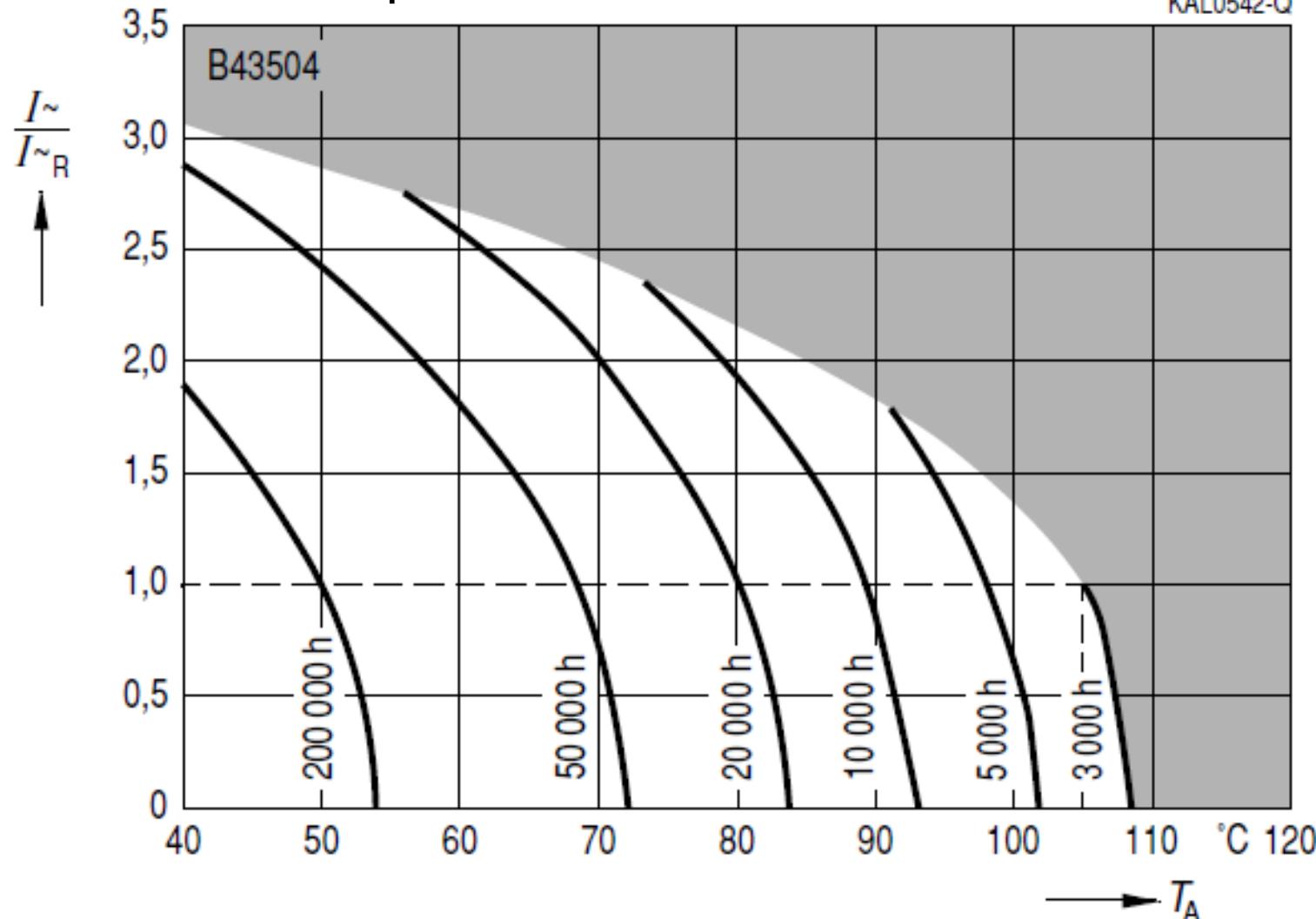
Capacitores Eletrolíticos: Variação da corrente com a frequência



B34504 EPCOS/TDK

Capacitores Eletrolíticos: Vida Útil

KAL0542-Q



B34504 EPCOS/TDK

I_{acR} = Corrente ca nominal a 105 graus Celsius

I_{ac} = Corrente ca que circula pelo capacitor

Capacitores Eletrolíticos: Vida Útil

Useful life		Requirements:
105°C; U_R ; $I_{\text{~R}}$	> 3 000 h	$\Delta C/C \leq \pm 30\%$ of initial value
85°C; U_R ; $I_{\text{~max}}$	> 6 500 h	$\tan \delta \leq 3$ times initial specified limit
40°C; U_R ; $1,9 \cdot I_{\text{~R}}$	> 200 000 h	$I_L \leq$ initial specified limit
		Failure percentage: $\leq 1\%$
		Failure rate: $\leq 40 \text{ fit} (\leq 40 \cdot 10^{-9}/\text{h})$
		(for definiton "fit", refer to chapter "Quality", page 62)

B34504 EPCOS/TDK

I_{acR} = Corrente ca nominal a 105 graus Celsius

I_{ac} = Corrente ca que circula pelo capacitor

U_R = tensão nominal

Capacitores Eletrolíticos: Vida Útil

Aluminum Electrolytic Capacitors

Life expectancy

Aluminum electrolytic capacitors slowly degrade over time and once the capacitor has degraded beyond a specified amount, the capacitor is considered to have failed. Most capacitors are considered a failure when the capacitance has changed by 20 to 25% of its initial value.

Aluminum electrolytic Capacitors load life's ratings are generally expressed between 1000 and 10000 hours at their rated voltage, maximum temperature rating and with maximum ripple current applied to the capacitor. This means that the capacitance of the capacitor will not change by more than the amount indicated under the load life rating when the capacitor is operated at the stated conditions. Although the life expectancies appear be a short amount of time the following can increase them.

When the capacitor is operated at temperatures other than the maximum rated temperature for the capacitor the expected life of the capacitor will increase. The rate of increase in operating life is for the life to double for every 10°C decrease in temperature (Arrhenius's law).

Fonte: Illinois Capacitor, Inc.

Cálculo de Vida Útil do Capacitor



TDK Electronics

AlCap Useful Life Calculation Tool

[Data sheet](#)

[Back](#)

[Help](#)

Capacitor selection	<input type="radio"/> Series name	B43701	Rated voltage *	V	Rated temperature	°C
	<input type="radio"/> Ordering code	B43701	Rated capacitance *	µF	Rated useful life	h
	<input type="radio"/> CSC code		Diameter x Length *	mm x mm	Rated ripple current	A

Load profile	<input type="radio"/> Calculation method	<input checked="" type="radio"/> Ripple current spectrum	<input type="radio"/> Measured temperatures															
	Load condition no.																	
	Time fraction	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total %	%
	Operating voltage *	V																
	Ambient temperature *	°C	<input type="radio"/> Current component no.	1	2	3	4	5	6							Hz	<input type="radio"/> Total	
Air speed	m/s	<input type="radio"/> Frequency																
		<input type="radio"/> Ripple current																
<input type="radio"/> Copy from load condition no. <input type="button" value=""/>																		

Calculation results	<input type="button" value="Print"/>
	The calculation results obtained are typical values and are intended for guidance purposes only. The useful life does not constitute a warranty of any kind or a prolongation of the agreed warranty period.

Capacitores Eletrolíticos: Tensão Máxima

B34504 EPCOS/TDK

Specifications and characteristics in brief

Rated voltage U_R	200 ... 450 VDC
Surge voltage U_S	$1,15 \cdot U_R$ (for $U_R \leq 250$ VDC) $1,10 \cdot U_R$ (for $U_R \geq 400$ VDC)
Rated capacitance C_R	47 ... 2 200 μF
Capacitance tolerance	$\pm 20 \% \triangleq M$

3.1.3 Surge voltage V_S

The surge voltage is the maximum voltage which may be applied to the capacitor for short periods of time, i.e. up to 5 times for 1 minute per hour. IEC 60384-4 specifies the surge voltage as follows:

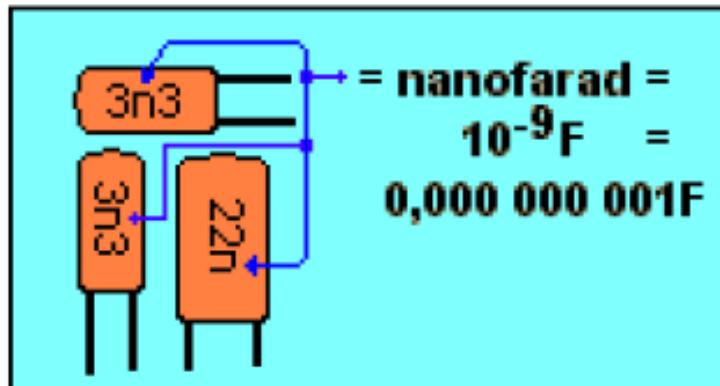
for $V_R \leq 315$ V: $V_S = 1.15 \cdot V_R$

for $V_R > 315$ V: $V_S = 1.10 \cdot V_R$

Capacitores

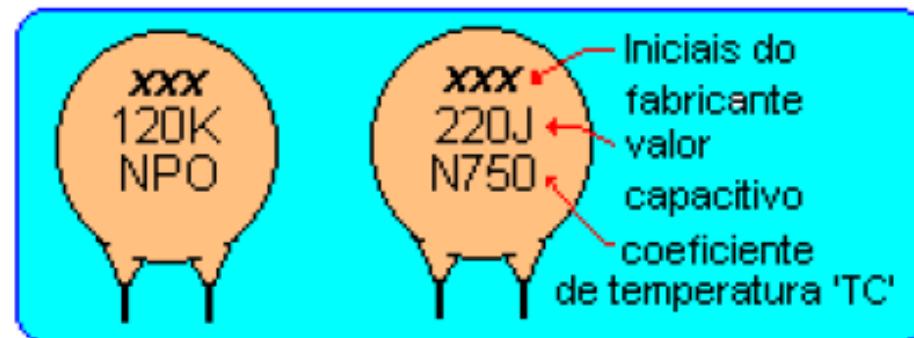
Leitura dos valores:

- ▶ Polipropileno, polister e policarbonato



- ▶ Cerâmico:

120
12x10⁰ pF



220
22x10⁰ pF

Capacitores

Leitura dos valores:

- ▶ Eletrolítico

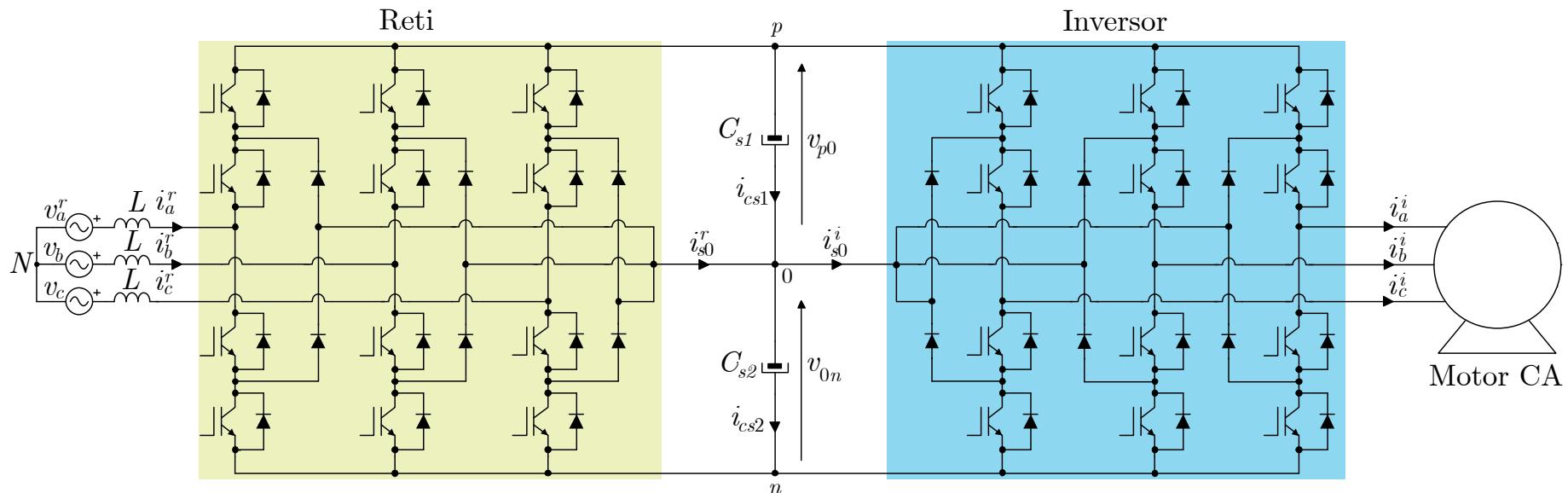


Comparativo Capacitor Filme x Eletrolítico:

- Capacitores de Filme apresentam menor resistência série equivalente (Redução de Perdas);
- Capacitores de Filme suportam tensão maiores (até 1.600 Vdc);
- Capacitores de Filme apresentam maior vida útil:
 - Capacitores eletrolíticos têm vida útil típica de 6,5 kh com operação nominal
 - Capacitores de filme têm vida útil típica de 100 kh com operação nominal
- Capacitores de Filme suportam alta ondulações de corrente;
- Capacitores de Filme apresentam baixa capacidade por unidade;
- Capacitores de Filme apresentam alto volume (farad x volume);
- Capacitores de Filme apresentam custo relativo maior por farad;

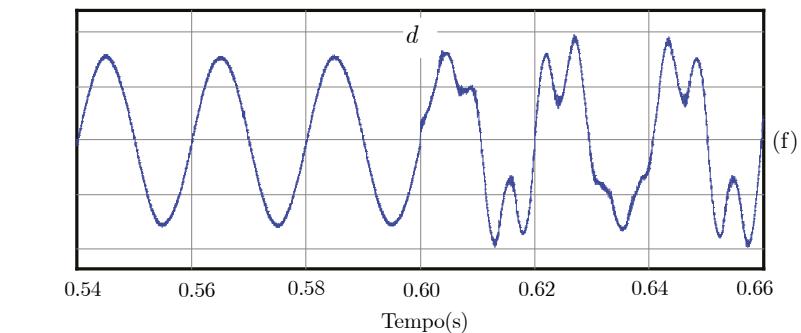
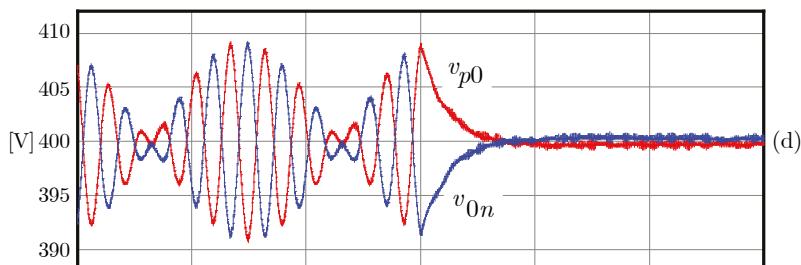
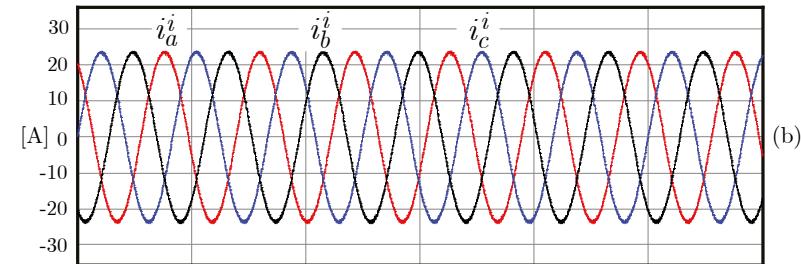
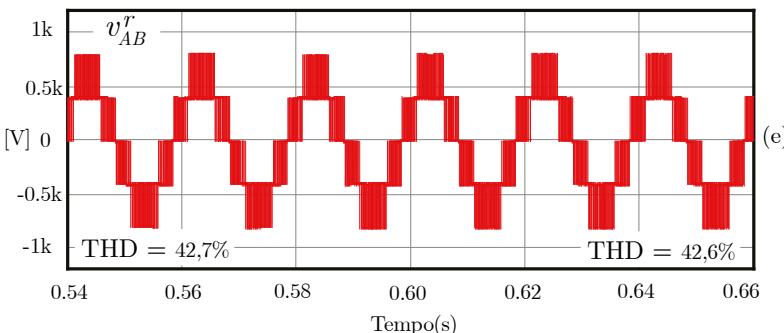
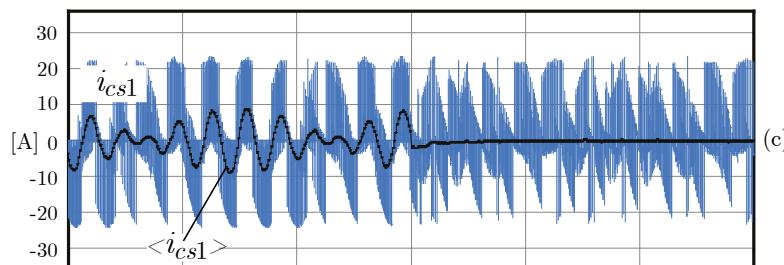
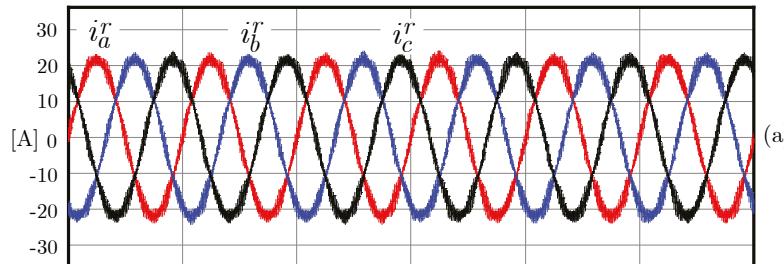
Inversor Trifásico Bidirecional

- Sistema *Back-to-Back* (B2B) baseado no conversor NPC três fios/fases/níveis é amplamente utilizado:
 - Geração Eólica;
 - Sistemas de Energias Renováveis;
 - Propulsão Marinha;
 - Acionamento de Máquinas em Corrente Alternada (CA).



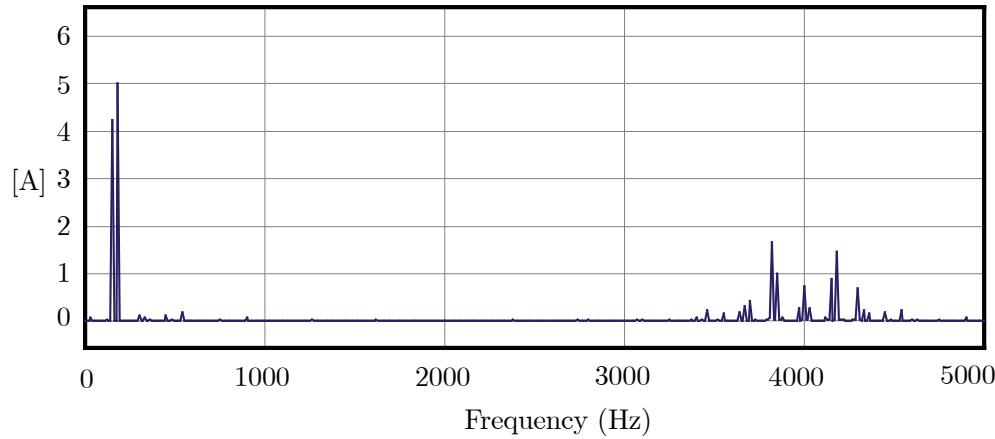
Inversor Trifásico Bidirecional

- Apresentam componentes de corrente de baixa frequência (BF) nos barramentos parciais, ocasionando ondulações:
 - A causa se deve às correntes injetadas no ponto central do sistema, oriundas do retificador e do inversor, três vezes a frequência do sinal de modulação;



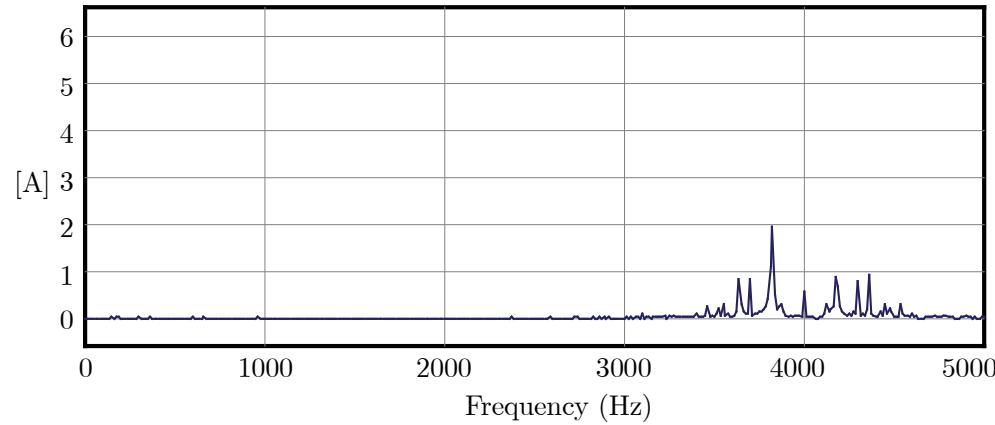
Inversor Trifásico Bidirecional

- FFT da corrente do capacitor do barramento positivo:



(a)

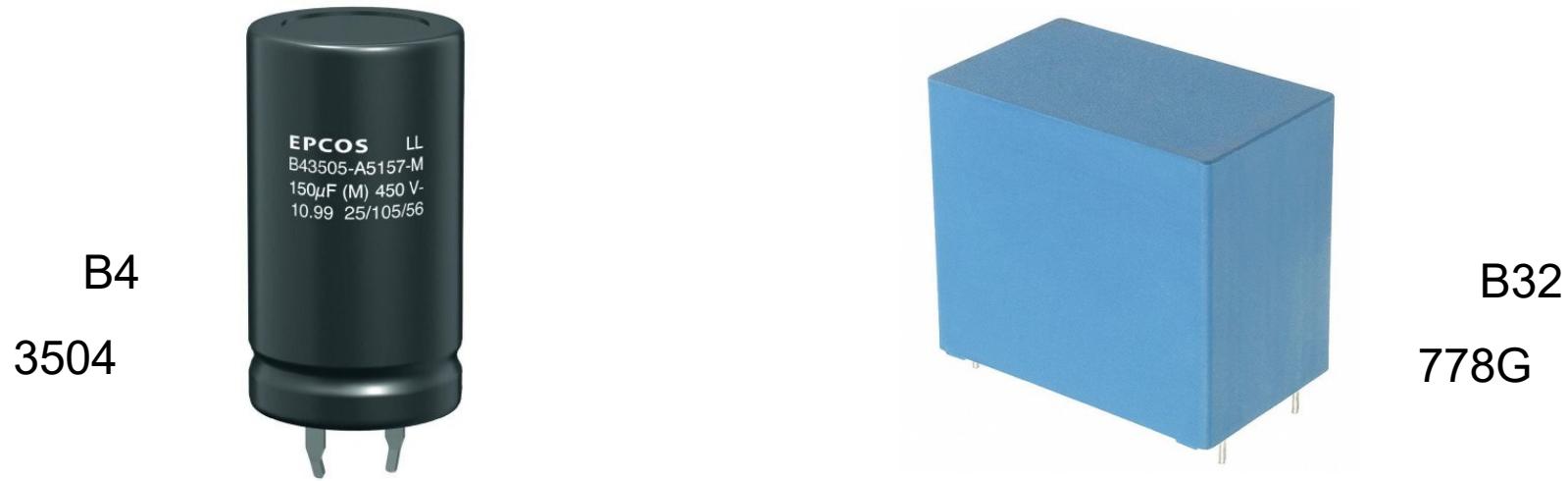
SPWM



(b)

Modulação Proposta

Exemplo: Fabricante EPCOS /TDK



Parâmetro	B43504	B32778G
Capacitância	1000 uF	50 uF
Tensão CC máxima	250 V	800 V
Corrente eficaz máxima	5,7 A (85°C e 100 Hz)	16 A (80°C e 10 kHz)
ESR	140 mΩ (20°C e 100 Hz)	6,3 mΩ (70°C e 10 kHz)
Tolerância	20%	10%
Vida útil	6.500 horas	100.000 horas
Dimensional	35 x 40 mm (d x h)	30x45x57,5 mm (w x h x l)

Inversor Trifásico Bidirecional

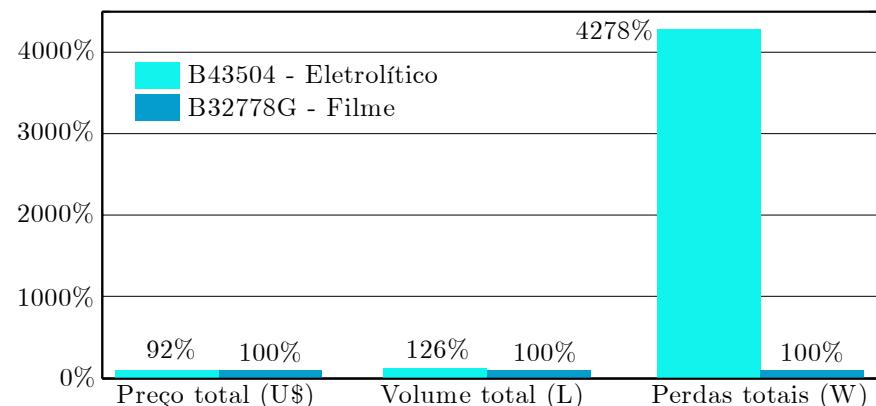
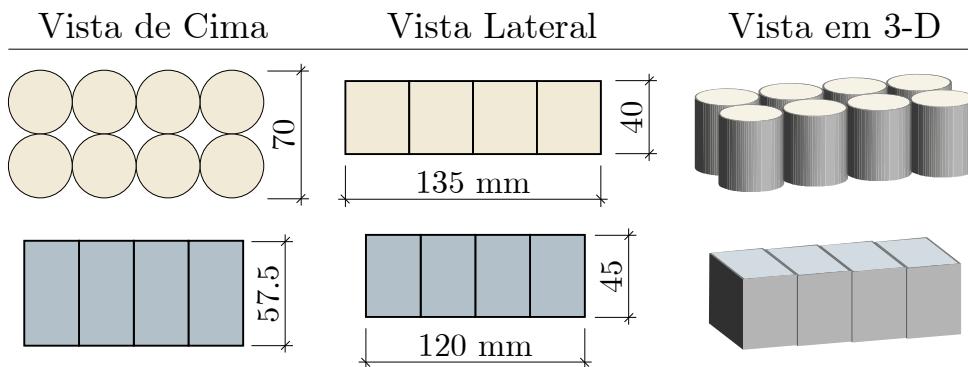


Parâmetros Motor Trifásico CA PMSM	Símbolo	Valor
Potência nominal mecânica	P_m	11,04 kW
Frequência nominal	f_m	60 Hz
Tensão de linha nominal	V_{Lm}	380 V
Torque nominal	T_m	57,86 N.m
Velocidade Nominal	ω_{rpm}	1.800 rpm
Número de Polos	p	4

Inversor Trifásico Bidirecional

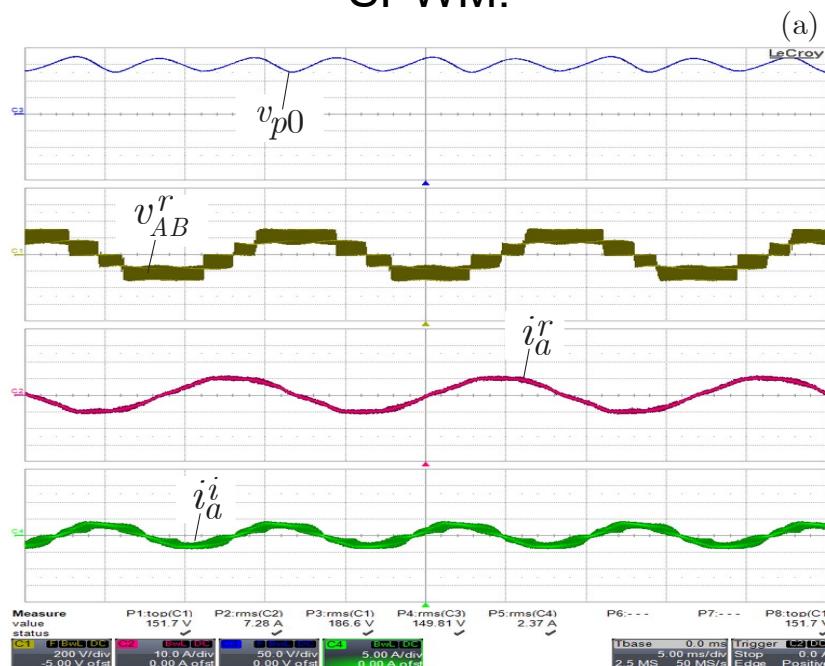
- Comparação entre os bancos de capacitores:

Parâmetro	B43504	B32778G
Preço total (U\$)	66,16	72,16
Volume total (L)	0,392	0,310
Perdas totais (W)	36,96	0,864

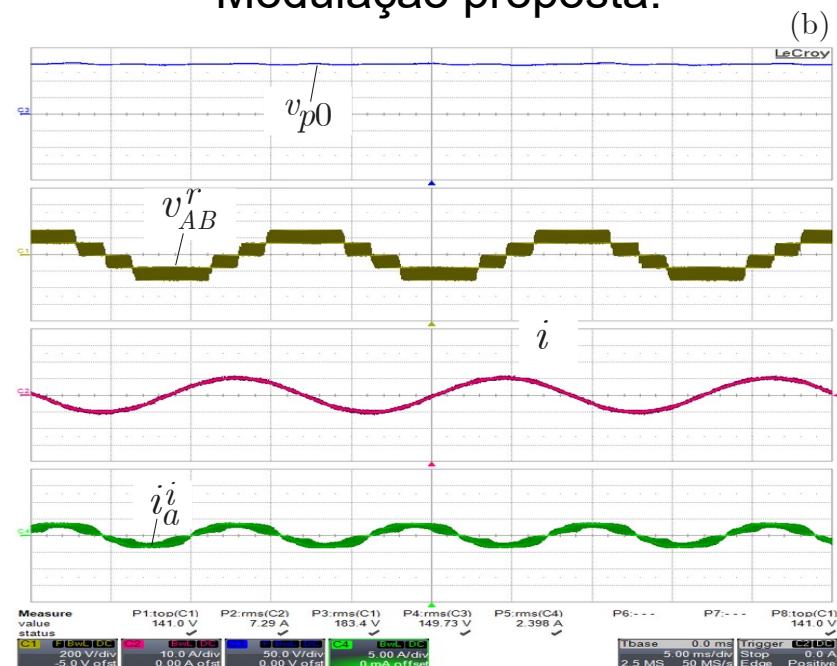


Inversor Trifásico Bidirecional

SPWM:

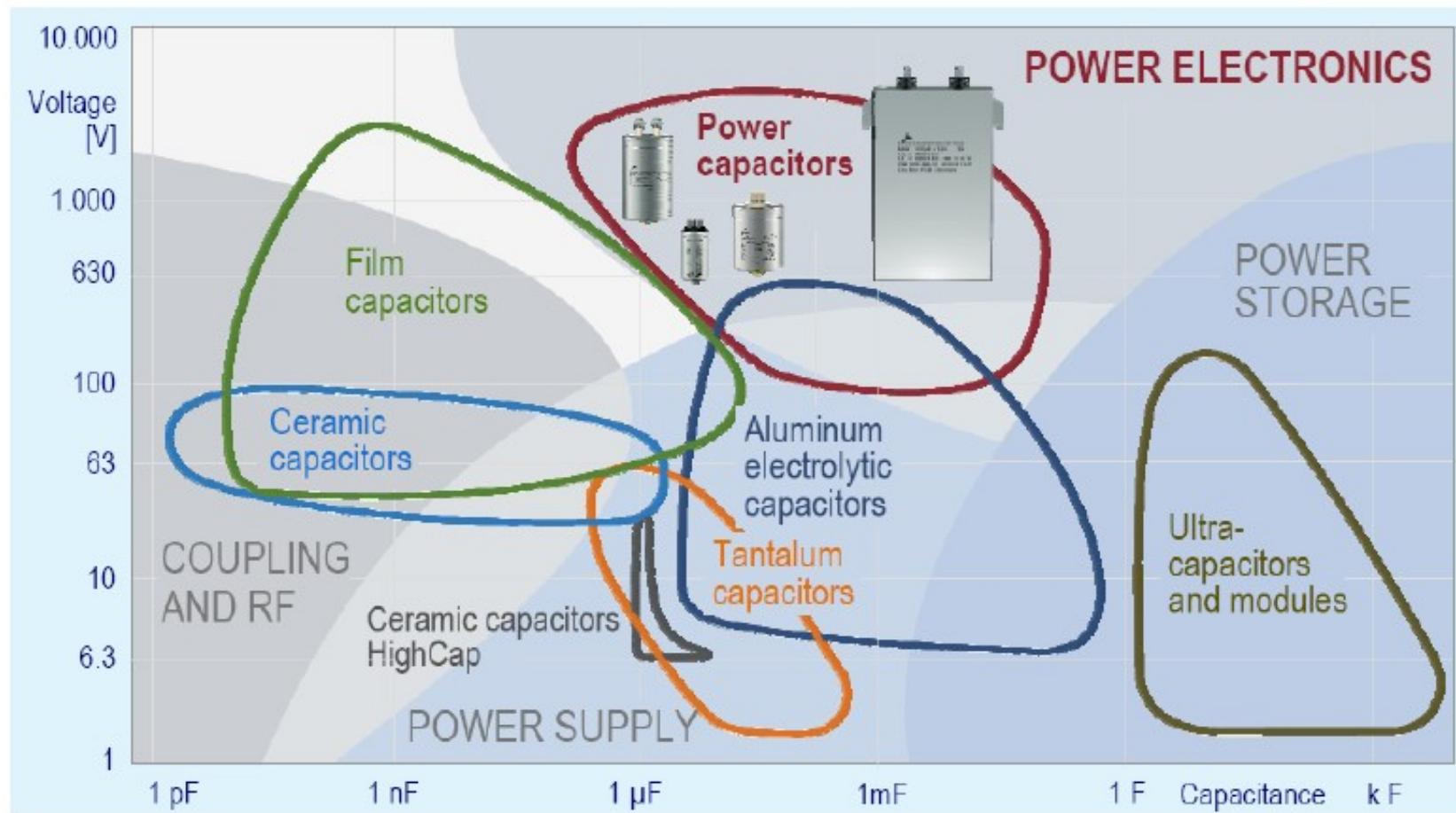


Modulação proposta:



- DSP =TMS320F28335 (TI): 150 MHz

Capacitors



Principais Fabricantes:

- EPCOS/TDK;
- United Chemi-Con
- Vishay;
- Nichicon;
- Kemet;
- Avx Corp;
- Murata;
- Panasonic;



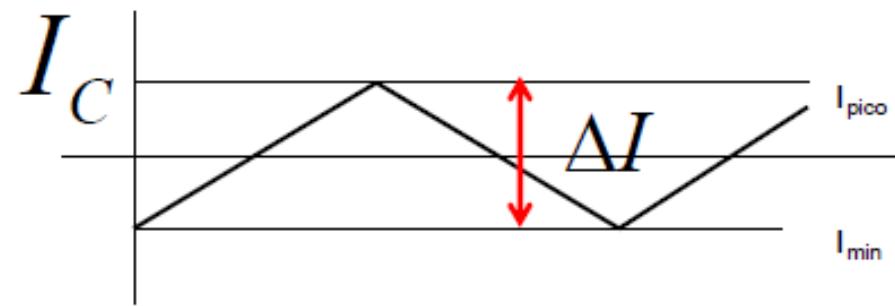
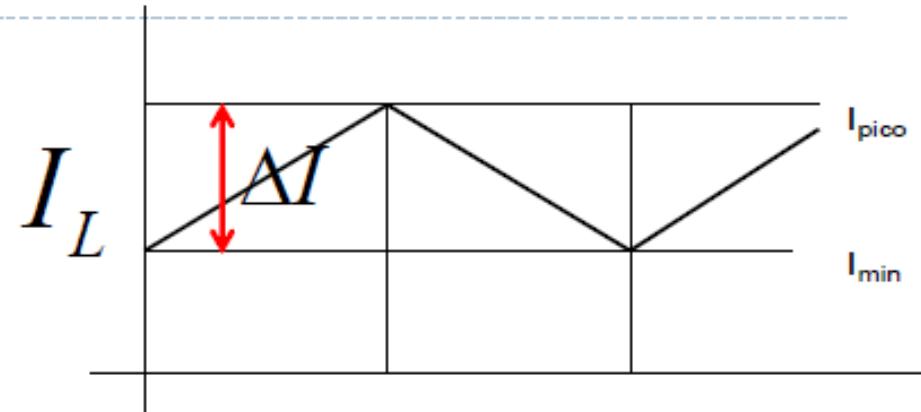
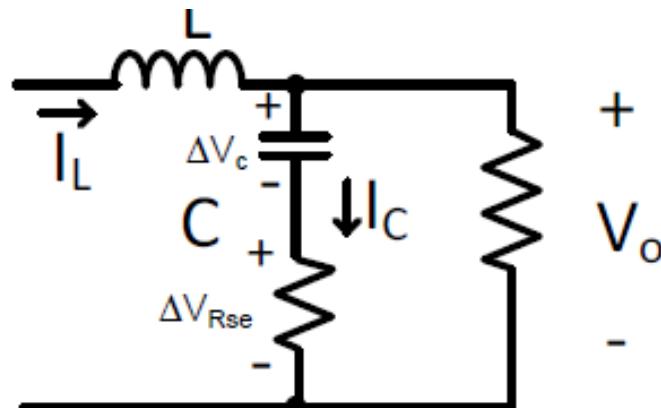
Dimensionamento de Capacitor:

- Valor da Capacitância mínima para o projeto (ΔV_c e ΔI_c);
- Tensão Máxima;
- Corrente Eficaz Máxima;
- Faixa de Temperatura (temperatura máxima);
- Perdas (observar a RSE corrente nas frequências);
- Custo, volume, espaço na PCI;

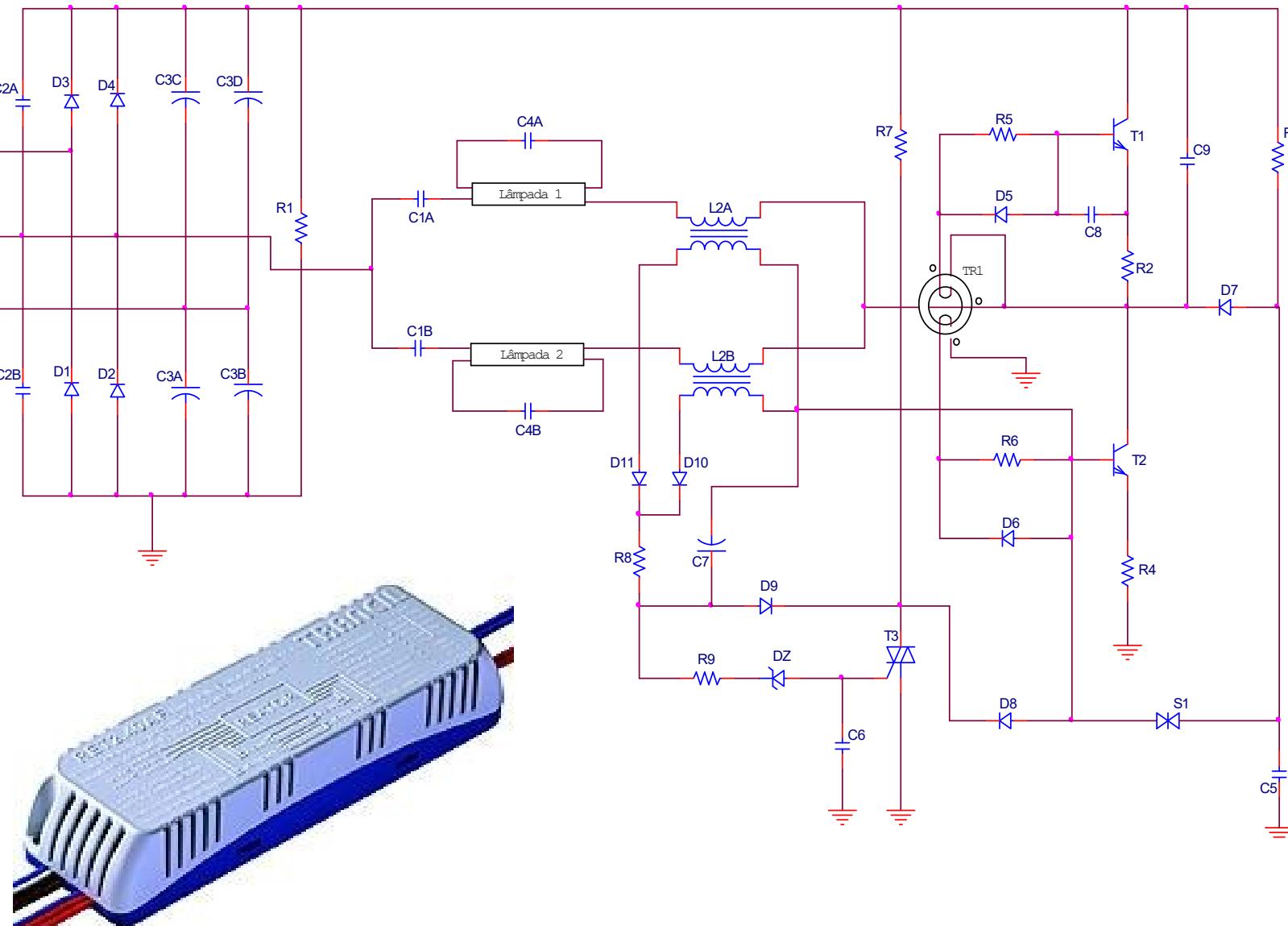
Capacitores

Dimensionamento:

- ▶ Cálculo da RSE;



Importante: Baixar custo com capacitores em série/paralelo



Capacitores em série/paralelo: Indicação do fabricante

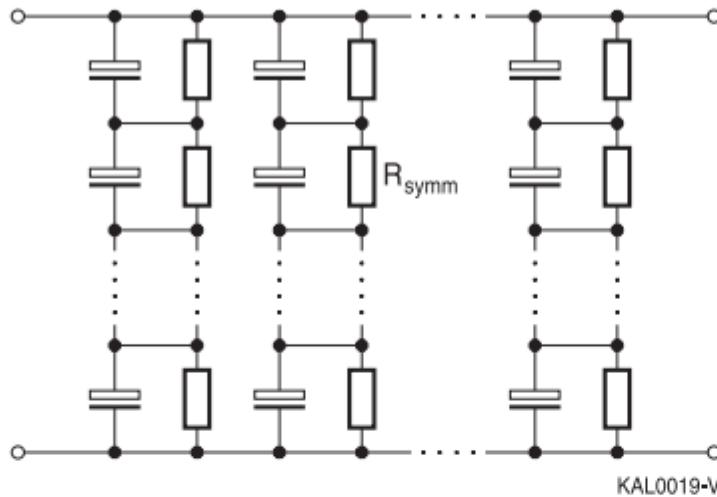


Figure 26
Combined parallel / series connection
(voltage balancing by shunt resistors)

The alternative solution, parallel connection of the series capacitors in the individual branch and the use of one balancing resistor for each capacitor group, is shown in figure 27.

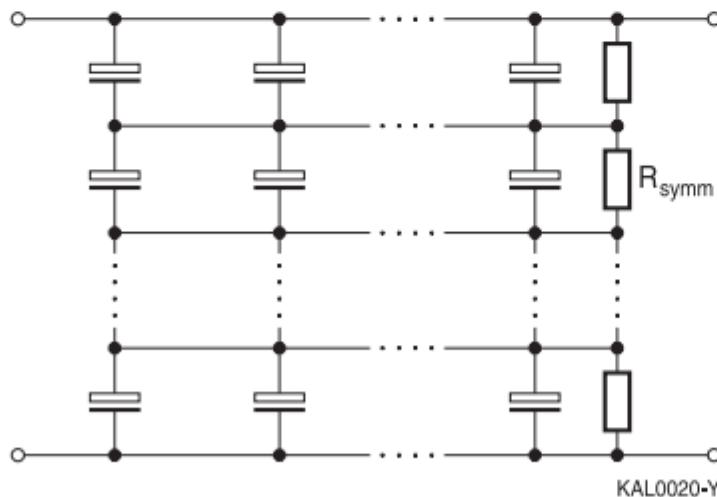
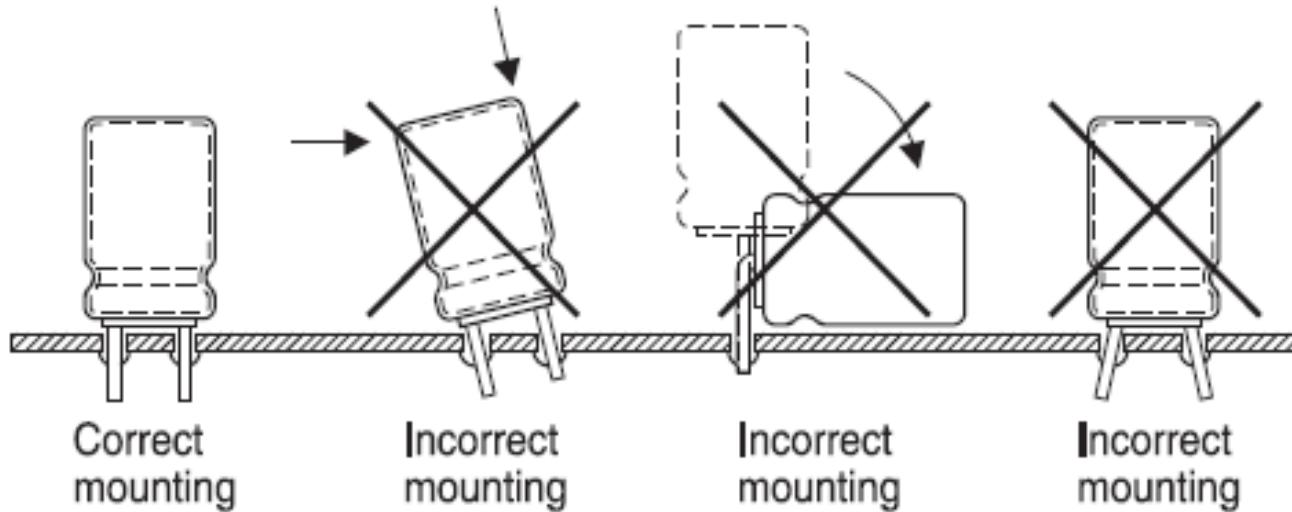


Figure 27
Combined parallel / series connection (group voltage balancing)

Capacitores Montagem: Indicação do fabricante



KAL1071-D-E

Figure 31
Mounting considerations for single-ended capacitors

Fonte: EPCOS

- Desenvolvimento completo do esquemático;
- Projeto do Conversor/Produto:
- Escolha dos semicondutores:
 - Diodos;
 - Transistores;
- Projeto Térmico: Dissipadores, ventiladores e etc;
- Projeto dos Magnéticos;
- Projeto do circuito passivos: resistores, capacitores e etc;
- Projeto dos filtros de EMI;
- **Proteções (corrente de in rush, surtos, sobrecorrente, sobretensão e etc);**
- Circuitos auxiliares (sensores, driver e etc);
- Circuitos integrados dedicados, microcontrolador, DSP e etc;
- Desenvolvimento do Gabinete e ferramentas;
- Desenvolvimento da PCI:
 - Protótipos;
 - DFM;
 - Inserção (PTH, SMD, misto);
 - Montagem;
 - Testes de produção
- Testes os protótipos;



Resumo do Projeto de Conversores Estáticos:

- ▶ Dimensionar semicondutores e elementos passivos para tolerar o pior situação de trabalho, especificações de projeto com menor custo.
- ▶ **Dimensionamento:**
- ▶ Interruptor: Máxima tensão, corrente média máxima e perdas térmicas.
- ▶ Diodos: Máxima tensão reversa, corrente média e perdas térmicas.
- ▶ Capacitores: Valor da capacitância, tensão máxima, corrente eficaz
- ▶ Indutor: Valor da indutância e corrente máxima eficaz.
- ▶ Transformador: relação de transformação, corrente eficaz no primário e no secundário, potência processada.

Exemplo de Softwares dedicados:

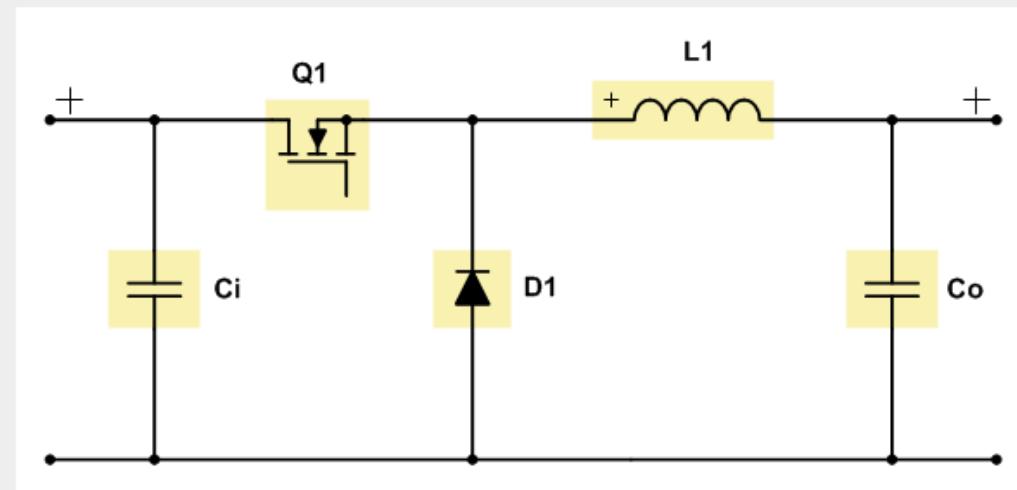
Power Stage Designer™ Tool - Version 3.0 - Buck

File Topology Help

Design Values

Minimum Input Voltage:	<input type="text" value="25"/> V
Maximum Input Voltage:	<input type="text" value="42"/> V
Output Voltage:	<input type="text" value="3.3"/> V
Output Current:	<input type="text" value="1.5"/> A
Switching Frequency:	<input type="text" value="500"/> kHz
Diode Voltage Drop:	<input type="text" value="0.7"/> V
Inductor Current Ripple:	<input type="text" value="25"/> %

Circuit Diagram



Calculated Values at Input Voltage: 25.00 V

Period:	2.00 μ s	Input Power:	5.84 W	Input Current:	0.23 A
Duty Cycle:	15.56 %	Output Power:	4.95 W	Current Ripple:	0.31 A
On-Time:	0.31 μ s	Diode Losses:	0.89 W		20.47 %
Off-Time:	1.69 μ s				
Zero-Time:	0.00 μ s				

[Check TI Designs™ Reference Design Library](#)
[Start WEBENCH® Design](#)

Info

Choose Value

Choose Inductance: μ H

TEXAS INSTRUMENTS

Metodologia de Projetos

WEBENCH® Power Designer

Get started with the industry's most powerful end-to-end design tool

WEBENCH® Power Designer creates customized power supply circuits based on your requirements. The environment gives you end-to-end power supply design capabilities that save you time during all phases of the design process.

[Try now](#) | Design | Easy to use | Latest features | Support and training



Easy power supply design. Select. Customize. Simulate. Export.

The new improved WEBENCH Power Designer makes designing power supplies easy.

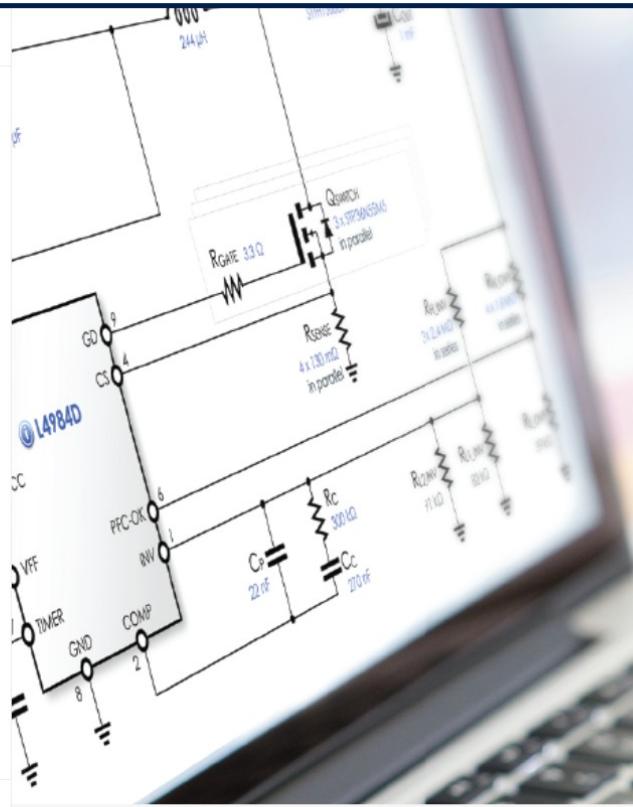
- Intuitive form inputs
- New improved layout
- Simulate, optimize, export, repeat...

[Try Power Designer now](#)

The screenshot shows the WEBENCH Power Designer interface. At the top, it says "WEBENCH® POWER DESIGNER Web". Below that, it says "Select a Design" with input parameters: Input: DC 14V - 28V, Output: 3.3V at 2A, Temp: 35°C, Change. There are tabs for "SELECT", "CUSTOMIZE", "SIMULATE", and "EXPORT". The "SELECT" tab is active. A "Filters" section includes "Regulator Type" (Module (Integrated Inductor), Converter (Integrated Switch), Controller (External Switch)) and "Design Attributes" (Efficiency (%): 75 - 100, BOM Cost (\$): 1 - 100, BOM Area (mm²): 0.0 - 100). Two designs are listed: "LM73605" and "LMR33620A-WSQN". Each listing includes a schematic diagram, efficiency, BOM count, BOM area, topology, frequency, and cost information.

Fonte: <http://www.ti.com/tools-software/design-center/webench-power-designer.html>

Metodologia de Projetos



The screenshot shows the eDesignSuite software interface. On the left is a sidebar with icons and labels for various design categories: Dashboard, Converter, Battery Charger, LED Driver, Photovoltaic, Signal Conditioning, RF Design, AC Control, Smart Selectors, Configurators, and Help. The main area displays a detailed circuit diagram for a power converter, specifically a boost converter using an L4984D IC. The diagram includes various components like resistors (R_{GATE}, R_{SENSE}, R_C, R_Z, R_M, R_B, R_{ON}, R_{OFF}), capacitors (C_G, C_S, C_{PFC}, C_{CC}, C_{VFF}, C_{TIMER}, C_{COMP}), and inductors (L₁, L₂). The IC is shown with its pins labeled: GND, V_{FB}, COMP, TIMER, GND, PFC-OF, NV, CS, GND, and GND. A note indicates "Quench 3.3VTP3.65mV in parallel". The software interface includes a top navigation bar with the ST logo, the text "eDesignSuite", and a "life.augmented" tagline. On the right, there is a "Previous Version" button and a small "s" icon. The overall theme is a professional engineering design tool.

All rights reserved ©2019 STMicroelectronics | [Terms of use](#) | [Privacy Policy](#)

Fonte: <https://my.st.com/analogsimulator/html/#/home>

Metodologia de Projetos

Power e SIM
www.poweresim.com

Login Eng 漢 汉

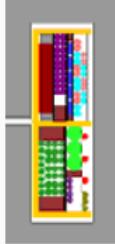
Better Than Real - Free Switch Mode Power Supply Circuit (SMPS) Design Software & Transformer Calculation / Simulation Tool.

| About | Free Account | Help Video | Support | Setting | Statistics | Testimonials | Custom Design | PowerEcal | Power Lab

Start a Design Step by Step Enter your specification below and press "Recommend Design"

AC Input Vin_{max} 240.0 V_{rms} Vo₁ 12.0 V
DC Input Vin_{min} 100.0 V_{rms} Io₁ 0 A - 4.0 A O/P

Power Supply Application: Adaptor Recommend Design Recommend Products

More Tools
Transformer Design

Magnetic Builder


Start a Design from Topology User can start a design from topologies below More Topologies ...

- Simple Flyback RCD
- Flyback PWM+S AC/DC
- Flyback Pri-Fb Quick Start
- Emitter Driven Flyback
- RCC Flyback AC/DC
- Pri. FB LED Bulb Driver
- LED Driver with PFC
- PFC CCM AC/DC
- PFC DCM AC/DC
- Interleaved PFC CCM
- Interleaved PFC DCM AC-DC
- Boost DC-DC
- Buck DC-DC
- Buck PNP
- Buck Boost DC-DC
- Buck Sync DC-DC
- Active Clamp AC/DC
- Resonate Reset Foward AC-DC
- Lossless Snubber Forward AC-DC
- LLC AC/DC
- LLC+SR AC/DC
- Full Bridge AC/DC
- Half Bridge AC/DC
- Asym Half Bridge AC/DC
- Phase Bridge AC/DC
- Push Pull AC/DC
- DC-AC H Bridge Inverter
- DC-AC Half Bridge Inverter
- Totem Pole PFC AC/DC
- Interleaved 2W Forward DC-DC
- VRM 1 Phase DC-DC
- Dual Vin Sync-Buck
- DC 1 Lamp Ballast HB Circuit
- DC 2 Lamp Ballast HB Circuit
- Standalone Xformer Design
- [More Topologies ...](#)

News Last update: 30/1/19 More...
GET IT ON Google Play Download on the App Store
• 2019-1-30: ★ New!

New Infineon reference design for Infineon 60W 12V 5V SMPS ICE5QSAG is now open to public.

• 2019-1-11: New Interface for waveform monitor.

PowerEsim's Sponsors More...

Never stop thinking

© Copyright 2019.
PowerEsim Limited.
All rights reserved.

Simulation & Design Counter
00000000000000000000000000000000

Metodologia de Projetos

power integrations® PI Expert Online

English 简体中文 繁體中文 日本語 한국어 Русский joabelm@gmail.com Logo

File Edit View Active Design Tools Help

Schematic Design Results Board Layout BOM Transformer Construction Design Evaluation

Design Passed (No Optimization)

InnoSwitch3-CE_PIDesign1.udb

Specifications

- Input
- Outputs
- Safety and Thermal

Design

- Options
- Key Parameters

Input Section

- Rectifier, Fuse, Surge
- Capacitors
- EMI Filter

PI Device

- Selection
- UV/OV
- Heatsink
- IS Pin Circuit
- Output OVP
- Feature Code

Primary BIAS

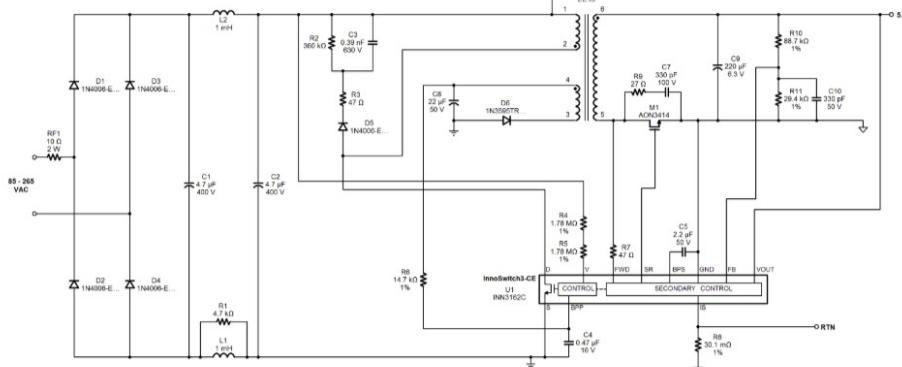
- Snubber
- RBIAS circuit components

Transformer

- Core Selection
- Bobbin Selection
- Requirements and Test

Winding Construction

Hide



Schematic components that have been frozen by the user will appear with blue reference designators.

Specification

- Topology: Flyback
- Family: InnoSwitch3-CE
- Package: C (inSO-24D)
- Breakdown Voltage: 650
- Feedback Type: Secondary Divider
- Line Frequency: 50
- Input Voltage Type: Universal (85 - 265 V)
- Use SR on Main Output: YES
- Total Peak Power: 5.00
- Current Limit Mode: Standard

Documentation

- Product Page [InnoSwitch3-CE](#)
- Data Sheets [InnoSwitch3-CE Data Sheet](#)
- Design Examples
 - [DER-544 - 40 W Dual Output Power Supply](#)
 - [DER-535 - 65 W Power Supply](#)
 - [DER-537 - 36 W Network Power Supply](#)

PI Expert Online – Power Integrations

Metodologia de Projetos

viper VIPer Flyback Converter Design Help : Default.vpa

File Documentation About Help

Add Output Transil Clamper All Data BOM Waveform Primary Regulation

Quick Circuit Data

Efficiency : 80% @ 25°C

Output Power : 5,0W

Losses

Output : 626mW

Ipeak Primary : 274mA

VIPer at 31°C : 179mW

Primary Inductance: 1,7mH

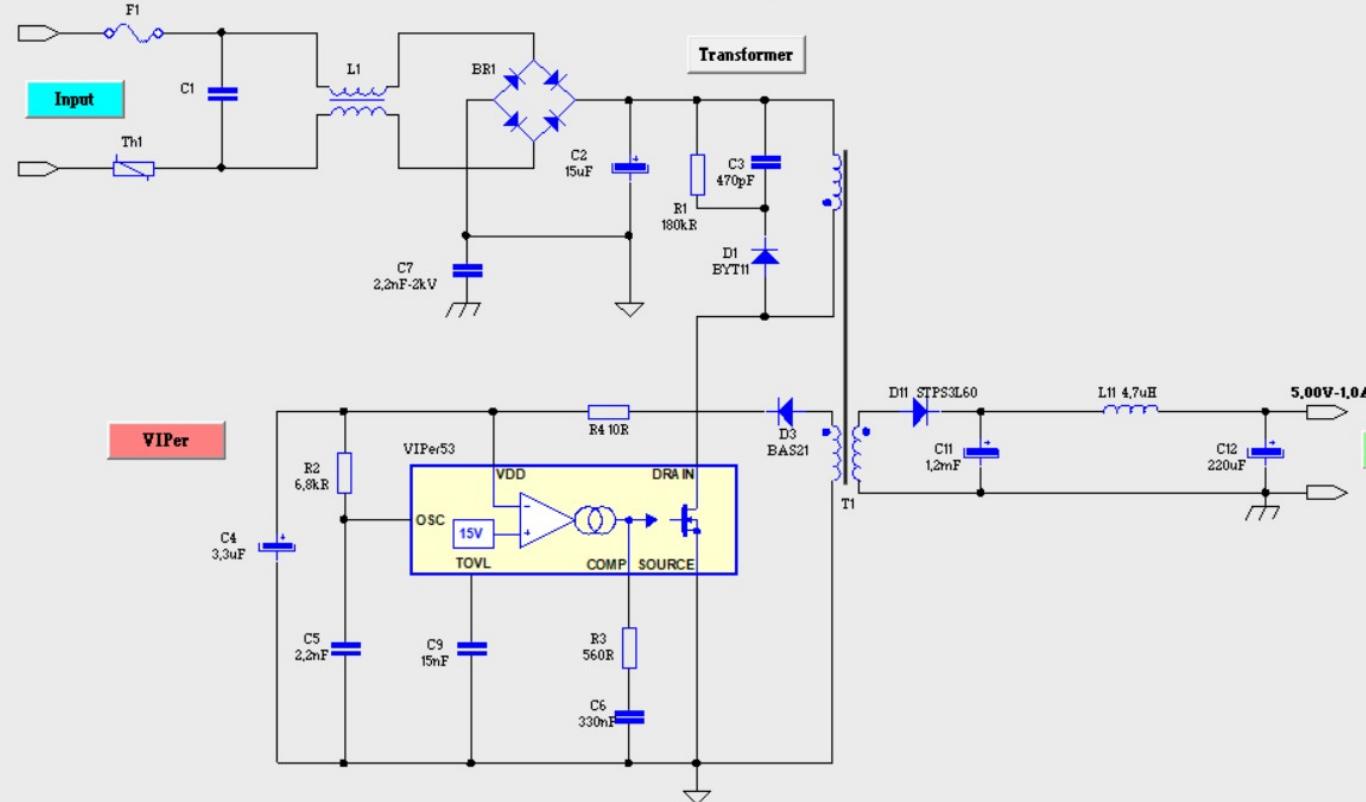
Clamper : 139mW

Continuous Mode : @ Low Line

Transformer : 291mW

Duty Cycle at Vmin : 49%

Project Name :



VIPER - ST

Application Notes/ Reference Design:

Other Design/Application Notes

AN-15: *TOPSwitch Power Supply Design Techniques for EMI and Safety*

AN-16: *TOPSwitch Flyback Design Methodology*

AN-17: Flyback Transformer Design for *TOPSwitch* Power Supplies

AN-18: *TOPSwitch Flyback Transformer Construction Guide*

AN-19: *TOPSwitch Flyback Power Supply Efficiency*

AN-20: Transient Suppression Techniques for *TOPSwitch* Power Supplies

DN-7: Power Factor Correction Using *TOPSwitch*

DN-8: Simple Bias Supplies Using the TOP200

DN-11: A Low-Cost, Low Part Count *TOPSwitch* Supply

DN-12: Non-isolated Flyback Supplies Using *TOPSwitch*

DN-14: Constant Current/Constant Power Regulation Circuits for *TOPSwitch*

DN-15: *TOPSwitch* Power Supply for Echelon PLT-21 Power Line Transceiver

DN-16: DC to DC Converters Using *TOPSwitch* for Telecom and Cablecom Applications

Reference Design/Evaluation Board Documentation

ST200: TOP200 Reference Design Board
95 to 370 Volt DC Input; 5V, 5W Output
(Replaced by RD1)

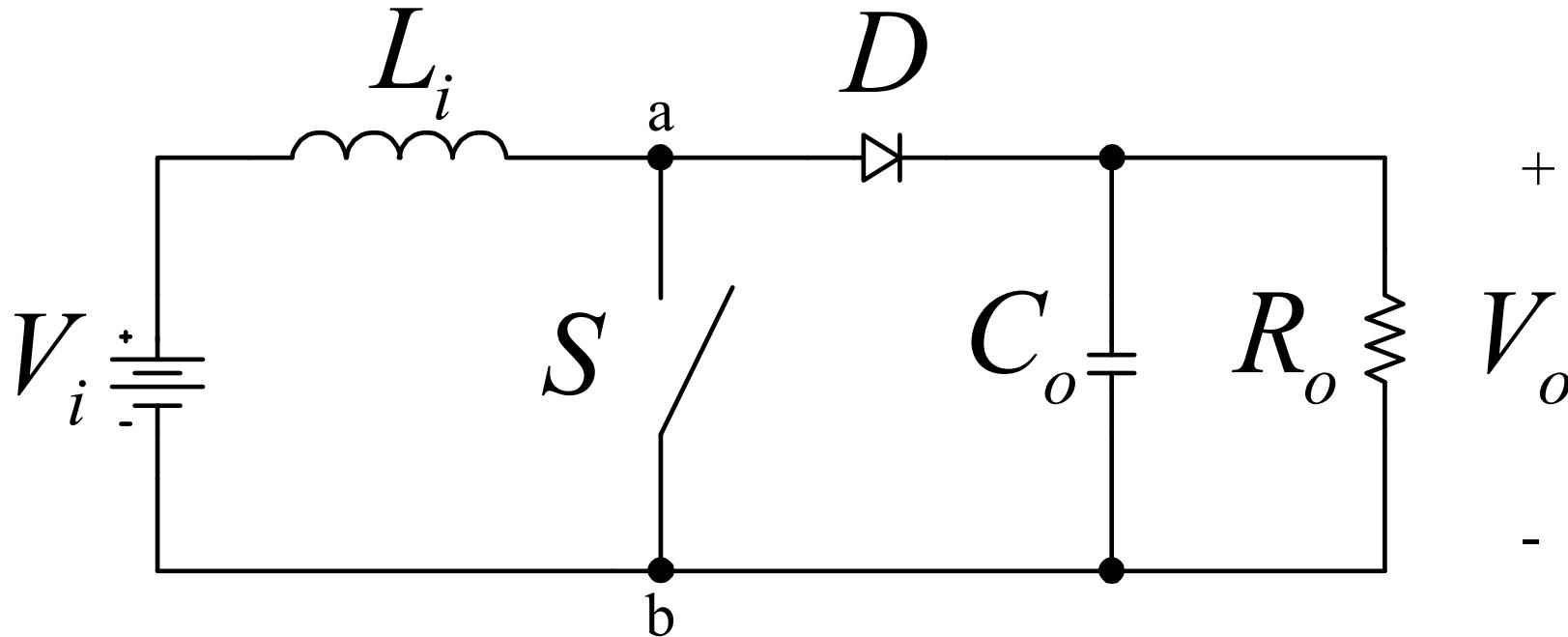
ST202A: TOP202 Reference Design Board
Universal AC Input; 7.5V, 15W Output

ST204A: TOP204 Reference Design Board
Universal AC Input; 15V, 30W Output

RD-1: TOP210 Reference Design Board
104 to 370 VDC Input, 4W Output

RD-2: TOP210 Reference Design Board
85 to 132 VAC or 170 to 265 VAC input; 8W Output

Conversor Boost CC-CC modo de condução Contínua (MCC):



Especificação:

- Tensão de Entrada: 25 V;
- Tensão de Saída: 50 V;
- Potência de Saída: 100 W;
- Frequência de Comutação: 20 kHz;
- Indutância de Entrada (L_i): 800 μ H;

Cálculos Preliminares

Razão Cíclica:

$$D = 1 - \frac{V_{in}}{V_o} = 1 - \frac{25}{50} = 0,5$$

Valor Médio da Corrente no Indutor:

$$I_{L_MED} = I_{in} = \frac{P}{V_{in}} = \frac{100}{25} = 4 \text{ A}$$

Valor Médio e Eficaz da Corrente do Transistor:

$$I_{S_med} = D \cdot I_L = 0,5 \cdot 4 = 2 \text{ A}$$

$$I_{S_ef} = \sqrt{D} \cdot I_L = \sqrt{0,5} \cdot 4 = 2,82 \text{ A}$$

Cálculos Preliminares

Tensão no Transistor bloqueado:

$$V_{DS(OFF)} = V_o = 50 \text{ V}$$

Ondulação da Corrente do Indutor:

$$\Delta_{iL} = \frac{V_{in} \cdot D}{L \cdot f} = \frac{25 \cdot 0,5}{800 \cdot 10^{-6} \cdot 20 \cdot 10^3} = 0,78 \text{ A}$$

Corrente de Pico no Transistor em Condução:

$$I_{DS(ON)} = I_{L_MAX} = I_{L_MED} + \frac{\Delta_{iL}}{2} = 4 + \frac{0,78}{2} = 4,39 \text{ A}$$

Projeto Semicondutores

Rogerio BUENO <rogerio.bueno@st.com>

sex, 4 de dez de 2015 15:18

para Magno, Sergio, eu ▾

Olá Joabel,

Tudo certo ?

Vc conseguiu simular a fonte com Viper ?

Com relação a sua fonte de capacitores chaveados de alta tensão, temos opções de mosfets até 1700V.

Para transistores na mais nova tecnologia K5, veja detalhes em :

http://www.st.com/web/en/catalog/sense_power/FM100/CL824/SC1168/SS1868?ecmp=tt2995_gl_enews_oct2015&sp_rid=NjkwODIzMzgwNTIS1&sp_mid=12387934

Para 1700V, temos :

<u>STW3N170</u>	Active	N-channel 1700 V, 7 Ohm typ., 2.6 A, PowerMESH Power MOSFET in TO-247 package
<u>STFW3N170</u>	Active	N-channel 1700 V, 7 Ohm typ., 2.6 A, PowerMESH Power MOSFET in TO-3PF package

Escolha do transistor



[Products](#) [Applications](#) [Tools](#) [About Infineon](#) [Careers](#)

Power
ASIC
Automotive System IC
ESD and Surge Protection
HiRel
Microcontroller
RF & Wireless Control
Security & smart card solutions
Sensor
Interface
Transistor & Diode
Evaluation Boards

This site uses cookies. By accepting cookies you can optimize your browsing experience. Please read our [Privacy Statement](#) and [Intelligent COVID-19 Modules \(IPCM\)](#).

- > Power
- > MOSFET
- > IGBT
- > Smart Low-Side & High-Side Switches
- > Linear Voltage Regulator
- > DC-DC Converter
- > Lighting ICs
- > Silicon Carbide (SiC)
- > High Power Diodes & Thyristors
- > Motor Control & Gate Driver ICs
- > AC-DC Power Conversion
- > Solid State Relay
- > Audio Driver ICs
- > Isolated Industrial Interface



≡ Menu

[Home](#) > [Power Transistors](#)

Power Transistors

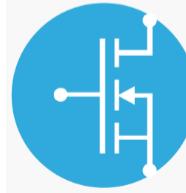
Leading-edge power technologies for both high-voltage and low-voltage applications combined with a full package range and innovative die bonding technologies exemplify ST's innovation in power transistors. Our portfolio includes **MOSFETs** ranging from -500 to 1700 V, **silicon carbide (SiC) MOSFETs** featuring the industry's highest temperature rating of 200 °C, **IGBTs** with breakdown voltages ranging from 300 to 1250 V and a wide range of **power bipolar transistors**.

Wide bandgap transistors



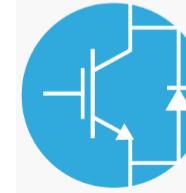
650 and 1200 V SiC MOSFETs featuring the

Power MOSFETs



Broad range of breakdown voltages from -500 V to 1700

IGBTs



Breakdown voltages from 300 to 1250 V. Low V_{CE(sat)}

Power Bipolar



The range includes Darlington transistors and



[SIGN IN](#)



Search Part #, Keyword, Cross-Reference



SEARCH TIPS

[PRODUCTS](#) [APPLICATIONS](#) [DESIGN](#) [LEARN](#) [EVALUATE](#) [SUPPORT](#) [WHERE TO BUY](#)

[Home](#) > [Products](#) > Discretes

Discretes

Fairchild's discrete portfolio spans from high voltage to small signal devices addressing system needs from the smallest mobile devices to full scale industrial applications. Our discrete products include field effect (FET) and bipolar (BJT) transistors, IGBTs, and a broad selection of diodes and rectifiers and circuit protection devices.

Fairchild has had a long history of innovation and leadership in both low voltage and high voltage MOSFET technologies. We are currently on our 10th generation of PowerTrench® devices with industry leading R_{DS(on)} and power density. With a focus on switch mode power supplies, our IGBTs and diodes are specifically designed to be the fastest and most efficient in the market.

Our unique position of providing both a full range of discrete products and leading edge power management ICs allows Fairchild to address a wide variety of critical application requirements and provide a total solution.

Discretes Portfolio

[Bipolar Transistors \(579\)](#)

[Diodes & Rectifiers \(1044\)](#)

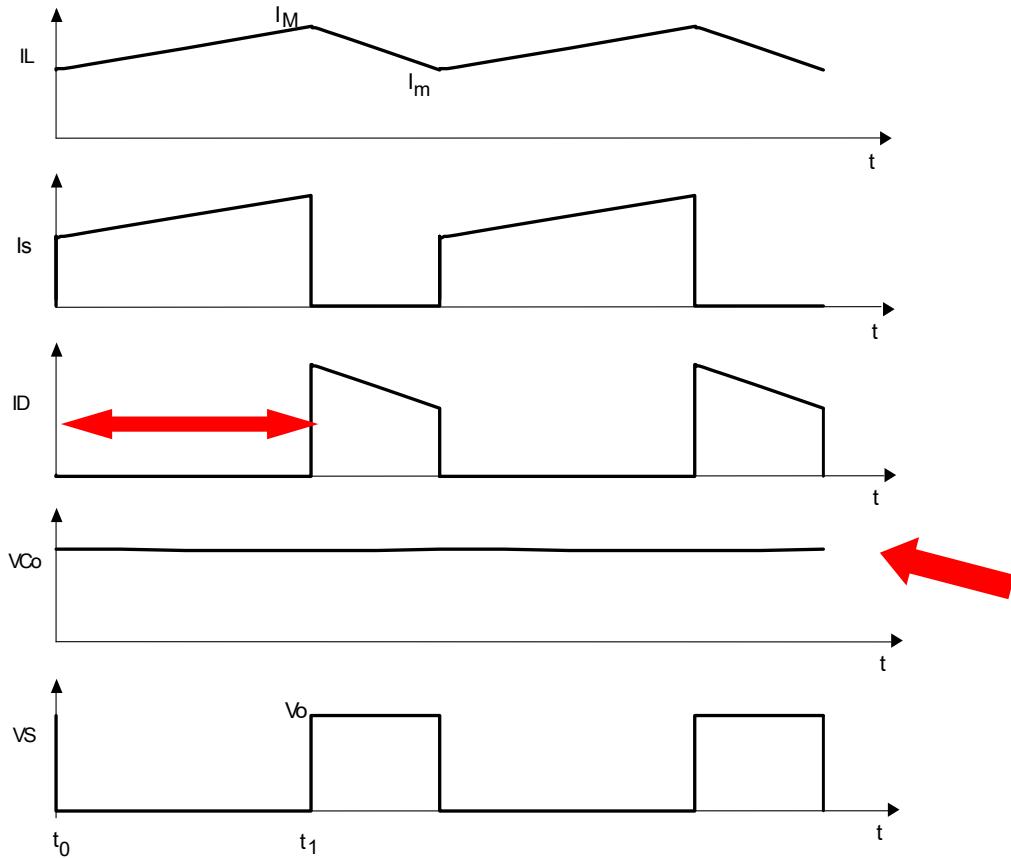
[IGBTs \(152\)](#)

[FETs \(1609\)](#)

[Circuit Protection \(345\)](#)

Conversor CC-CC elevador - Boost

Análise das grandezas envolvidas



Tensão no capacitor

$$i_C \approx I_{out} \quad \text{p/ primeira etapa}$$

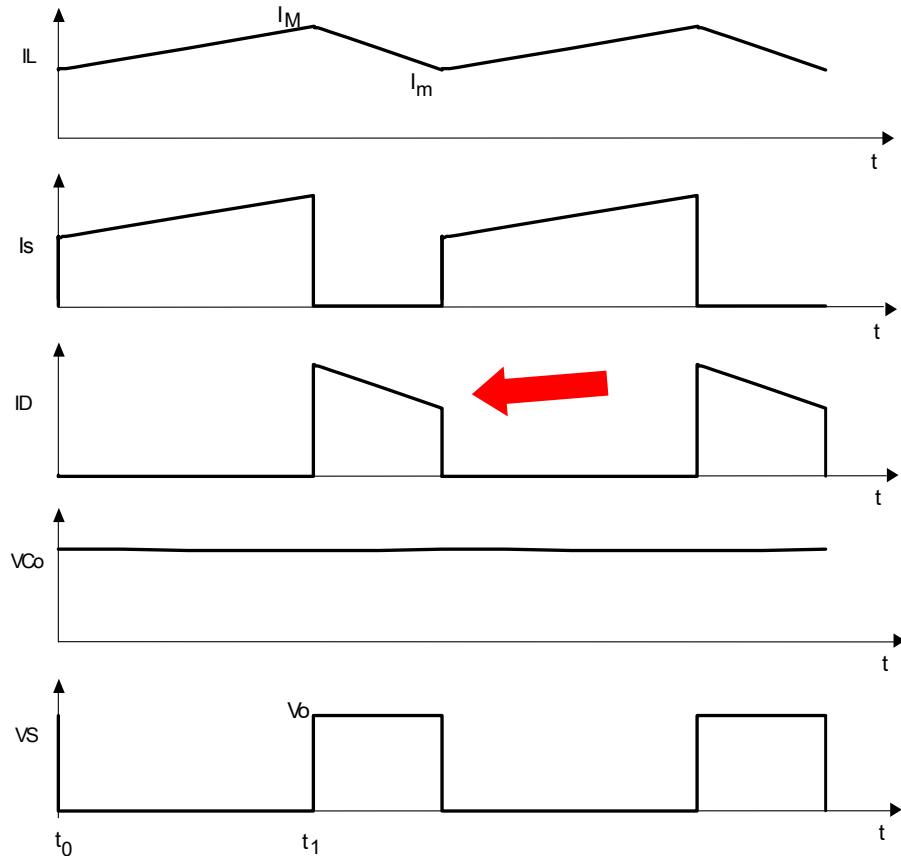
$$I_{out} = Co \cdot \frac{\Delta V_{Co}}{\Delta t}$$

$$\Delta V_{Co} = \frac{I_{out} \cdot \Delta t}{Co} = \frac{I_{out} \cdot D}{Co \cdot f}$$

$$\Delta V_{Co} = \frac{I_o}{C_o \cdot f} \cdot \frac{V_o - V_i}{V_o}$$

Conversor CC-CC elevador - Boost

Análise das grandezas envolvidas



Tensão no capacitor Efeito da RSE

$$V_{RSE} = RSE \cdot i_{D_{CA}} = RSE \cdot i_{Co}$$

$$P_{RSE} = RSE \cdot i_{D_{CAef}}^2 = RSE \cdot i_{Co}^2$$

Cálculos Preliminares

$$\Delta V_{Co} = \frac{I_o}{C_o \cdot f} \cdot \frac{V_o - V_i}{V_o}$$



$$C_o = \frac{I_o}{\Delta V_{Co} \cdot f} \cdot \frac{V_o - V_i}{V_o}$$

Cálculo do capacitor mínimo:

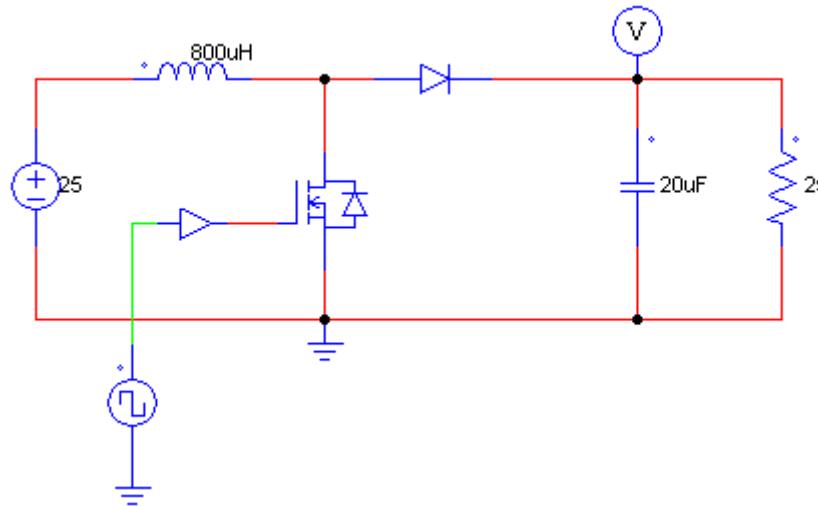
$$\Delta V_{Co} = 0,05 \cdot V_o = 0,05 \cdot 50 = 2,5 \text{ V}$$

$$C_o = \frac{I_o}{\Delta V_{Co} \cdot f} \cdot \frac{V_o - V_i}{V_o} = \frac{2}{2,5 \cdot 20k} \cdot \frac{50 - 25}{50} = 20 \mu F$$

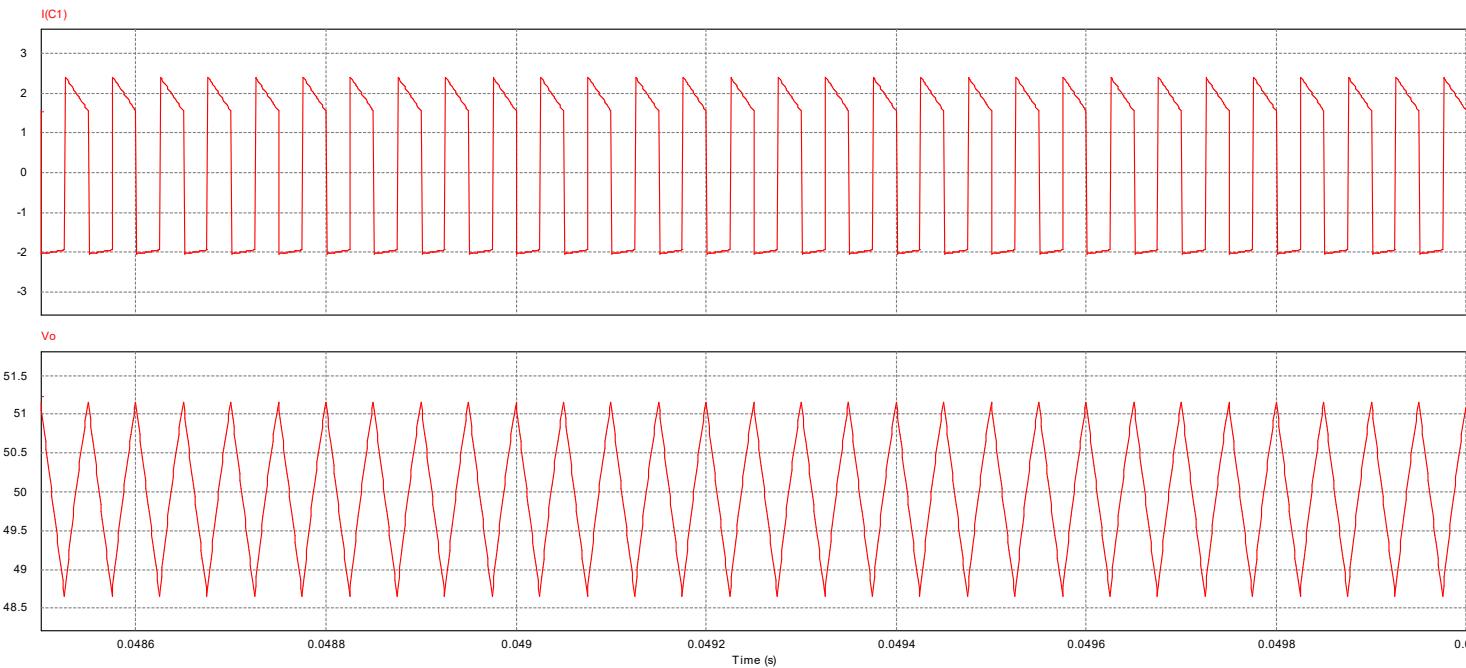
$$V_{Co} = V_o = 50 \text{ V}$$

$$I_{Co} = I_o \cdot \sqrt{\frac{D}{1-D}} = 2 \cdot \sqrt{\frac{0,5}{1-0,5}} = 2 \text{ A}$$

Simulação

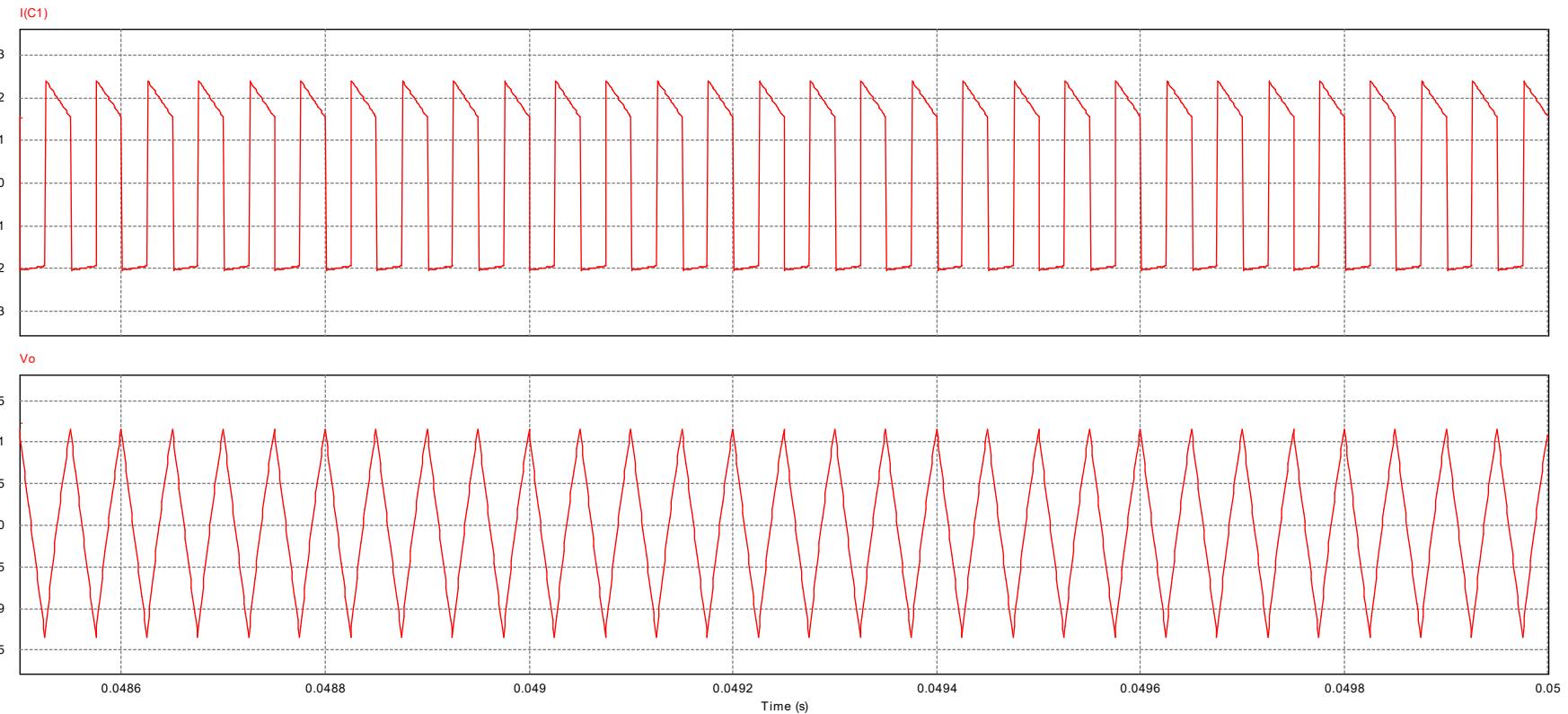


Corrente no Capacitor



Tensão no capacitor

Simulação



$$RSE = 0 \Omega$$

$$I_{Co} = 2 \text{ A (rms)}$$

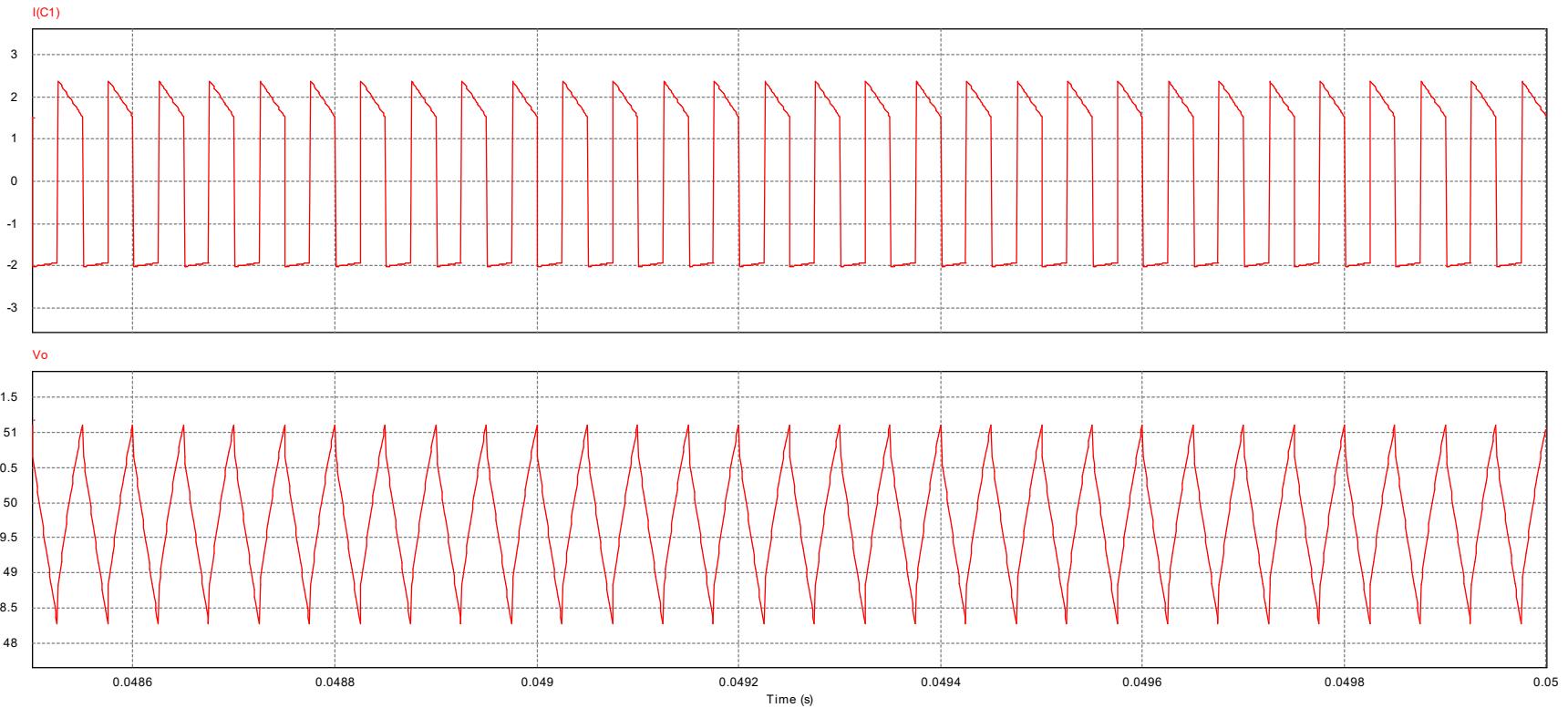
Valor da Tensão Média de Saída

$$V_o = 50 \text{ V}$$

$$\Delta I_{Co} = 4,5 \text{ A}$$

$$\Delta V_{Co} = 2,5 \text{ V}$$

Simulação



$$RSE = 0,1\Omega$$

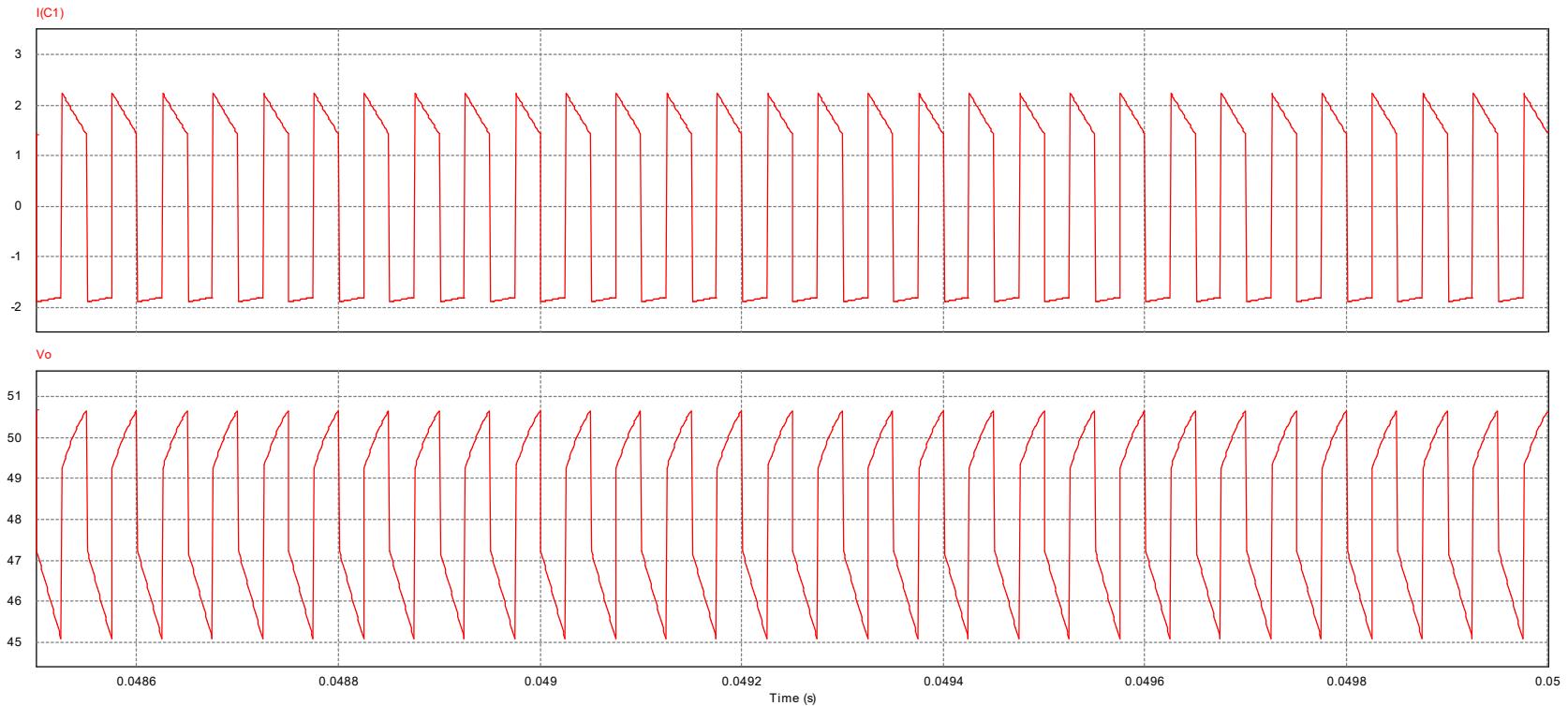
$$I_{Co} = 1,98 \text{ A (rms)}$$

Valor da Tensão Média de Saída

$$V_o = 49,75 \text{ V}$$

$$\Delta V_{Co} = 2,83 \text{ V}$$

Simulação



$$RSE = 1\Omega$$

$$I_{Co} = 1,85 \text{ A (rms)}$$

Valor da Tensão Média de Saída

$$V_o = 48 \text{ V}$$

$$\Delta V_{Co} = 5,5 \text{ V}$$

Escolha do Capacitor

$$I_{Co} = 2 \text{ A (rms)} \quad C_o = 20 \mu\text{F} \quad V_{Co} = 50 \text{ V} \quad f = 20 \text{ kHz}$$

$$\Delta V_{RSE} = RSE \cdot \Delta I_{Co}$$

[
RSE_{max} = $\frac{0,2 \cdot \Delta V_{Co}}{\Delta I_{Co}} = \frac{0,50}{4} = 0,125 \Omega$
]



TDK EPCOS • TDK Europe

[English](#) [Customer's Login](#) [RSS](#)

🔍

[Products](#) [Design Support](#) [Tech Library](#) [Company](#) [Contact](#)

Home

EMC components

Miniaturized LC filters for suppression of EMI

◀

TDK Corporation presents the MEM1005PP251T – a new LC filter for EMI suppression. With dimensions of just 1.0 x 0.5 x 0.35 mm the filters are ideally suited for use in smart phones and base stations.

[READ MORE](#)
▶



● ● ● ● ● ● ●

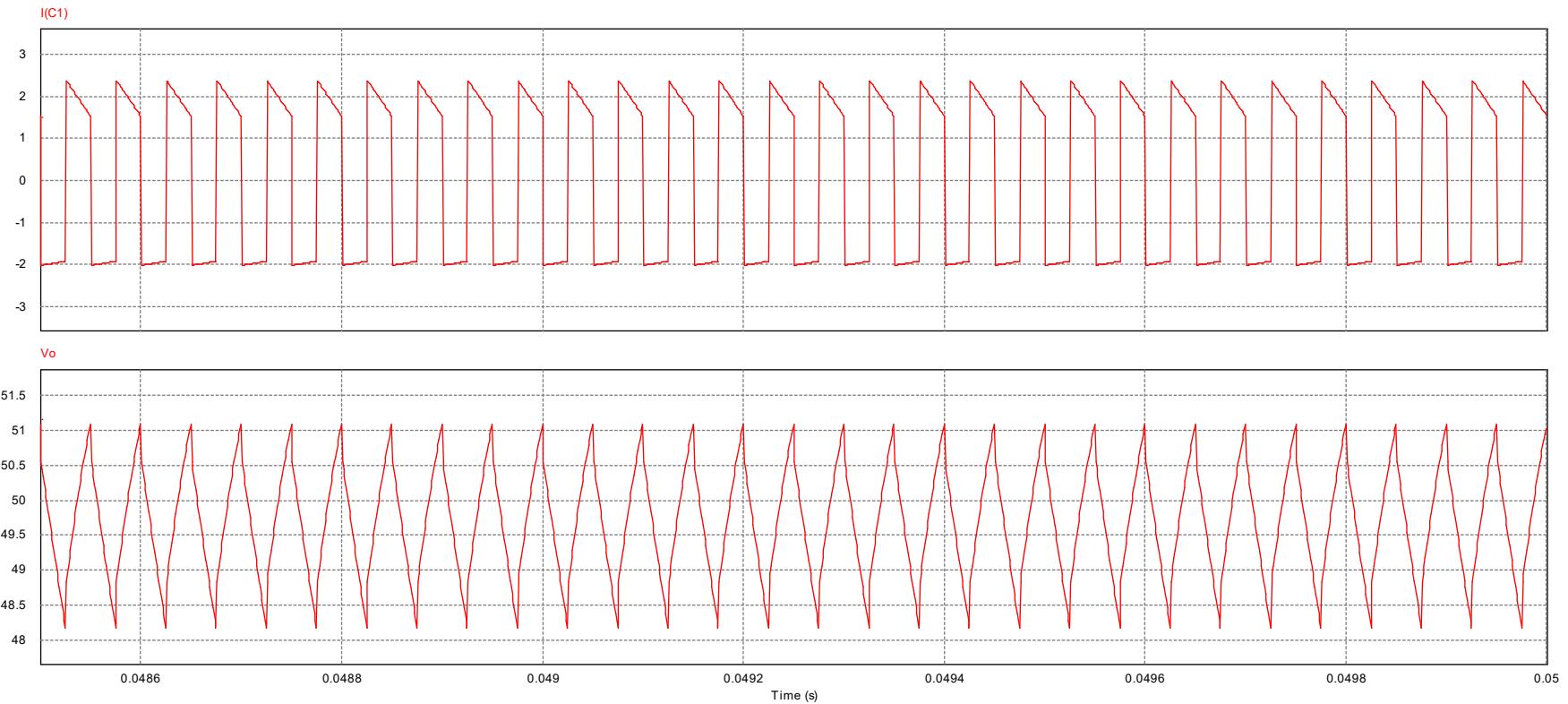
Products

- ▶ Aluminum Electrolytic Capacitors
- ▶ Film capacitors
- ▶ Components for Power Factor Correction
- ▶ RF Components and Modules
- ▶ Protection Devices
- ▶ Ceramic Switching and Heating Components/Piezoelectric Components
- ▶ Inductors (Coils)
- ▶ Ferrites and Accessories
- ▶ Magnets
- ▶ Wireless Power Transfer
- ▶ Further TDK Products (Noise Suppression Sheets etc.)

JOB & CAREER


Job Offers

Simulação



$$RSE = 0,125\Omega$$

$$I_{Co} = 1,975 \text{ A (rms)}$$

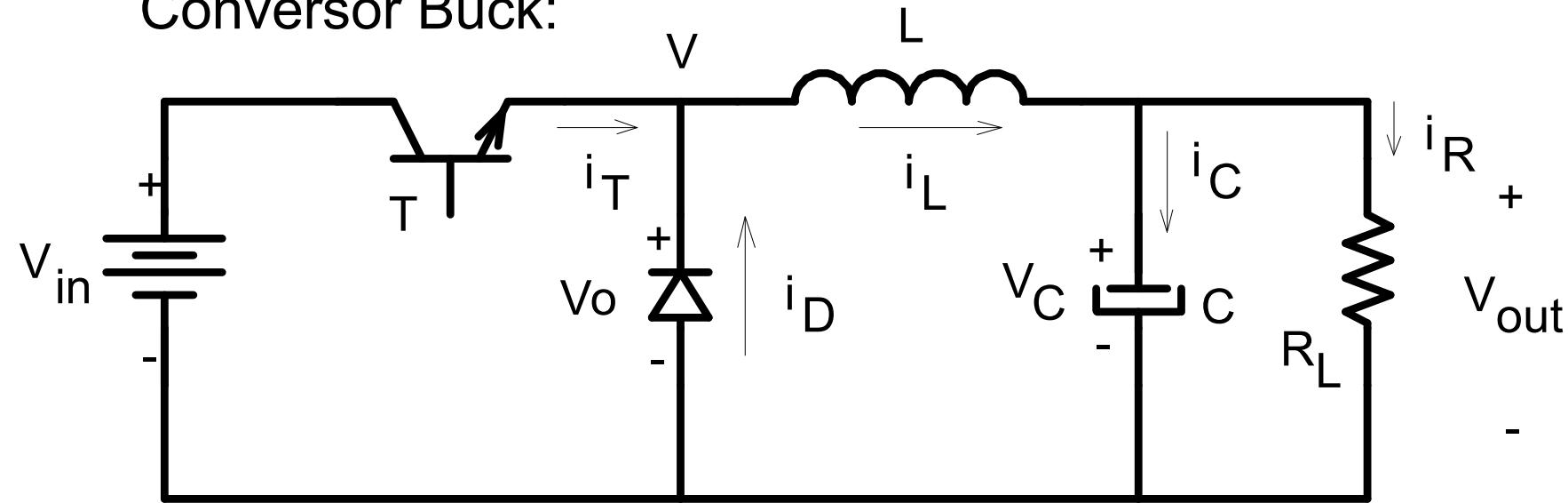
Valor da Tensão Média de Saída

$$V_o = 49,7 \text{ V}$$

$$\Delta V_{Co} = 2,9 \text{ V}$$

$$\Delta I_{Co} = 4,39 \text{ A}$$

Conversor Buck:



Especificação:

Tensão de Entrada: 36 V

Tensão de Saída: 12 V

Frequência de comutação: 50 kHz;

Indutância L: 100 uH

Potência: 100 W;

Especificar:

- Díodo, transistor e capacitor
- Calcular Perdas no transistor
- Especificar os dissipadores, se necessário