

LOM3221 – LABORATÓRIO DE ELETRÔNICA

AULA 12

Prof. Dr. Emerson G. Melo

Dissipador de Calor;

- Resistência Térmica;

- Fonte Regulada: Temperatura da Junção sem Dissipador de Calor;

- Fonte Regulada: Temperatura da Junção com Dissipador de Calor;

- Fonte Chaveada: Perdas por Condução e Chaveamento;

- Fonte Chaveada: Temperatura da Junção sem Dissipador de Calor;

- Fonte Chaveada: Temperatura da Junção com Dissipador de Calor.

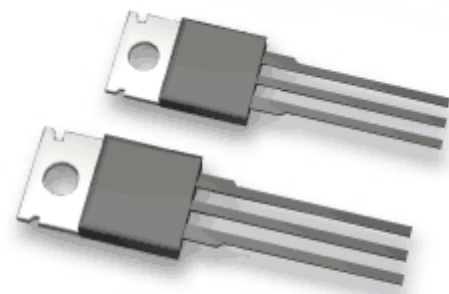
Dissipador de Calor

- ❑ Quando as condições de operação não permitem que a temperatura de junção dos dispositivos de regulação/chaveamento permaneçam dentro de limites seguros, é necessário acrescentar um dissipador de calor ao projeto.

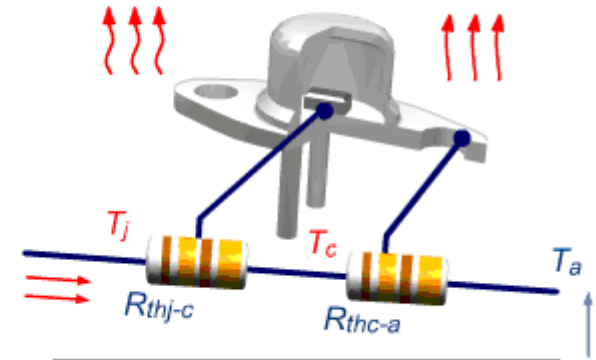


Resistência Térmica.

$$R_{\theta} = \frac{\Delta T}{P}$$



$$P = VI$$



$$\Delta T = T_j - T_a$$

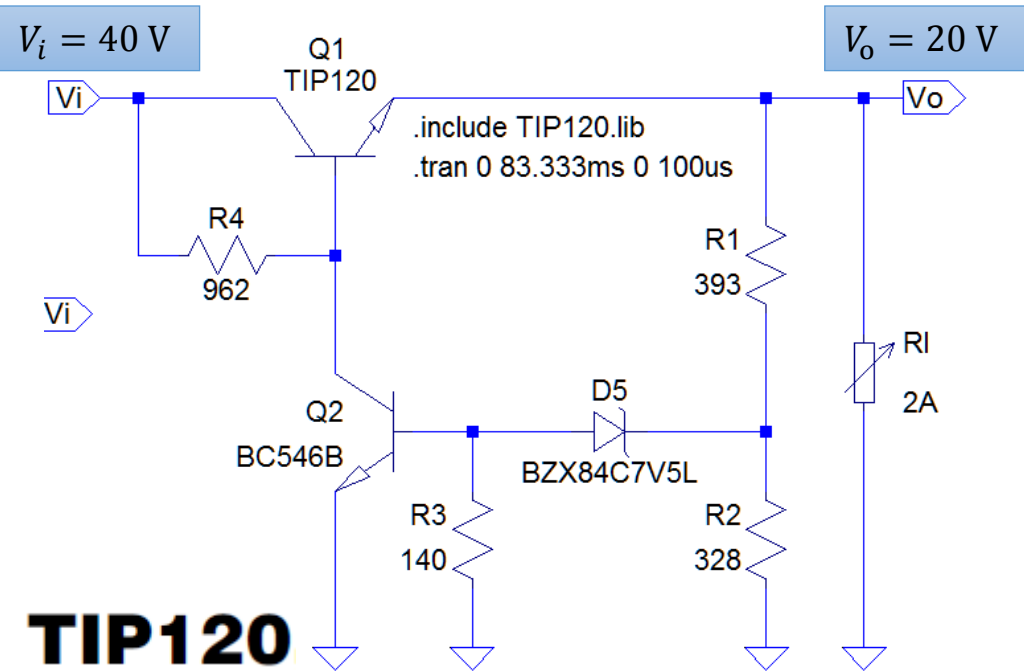
$$R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$$

TIP120

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	1.92	$^{\circ}\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	62.5	$^{\circ}\text{C}/\text{W}$

Fonte Regulada: Temperatura da Junção sem Dissipador de Calor



TIP120

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	1.92	$^{\circ}\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	62.5	$^{\circ}\text{C}/\text{W}$
Operating and Storage Junction, Temperature Range	T_J, T_{stg}	-65 to +150	$^{\circ}\text{C}$

$$P = VI = (40 - 20)2 = 40 \text{ W}$$

$$R_{\theta JA} = 62,5 \text{ }^{\circ}\text{C}/\text{W}$$

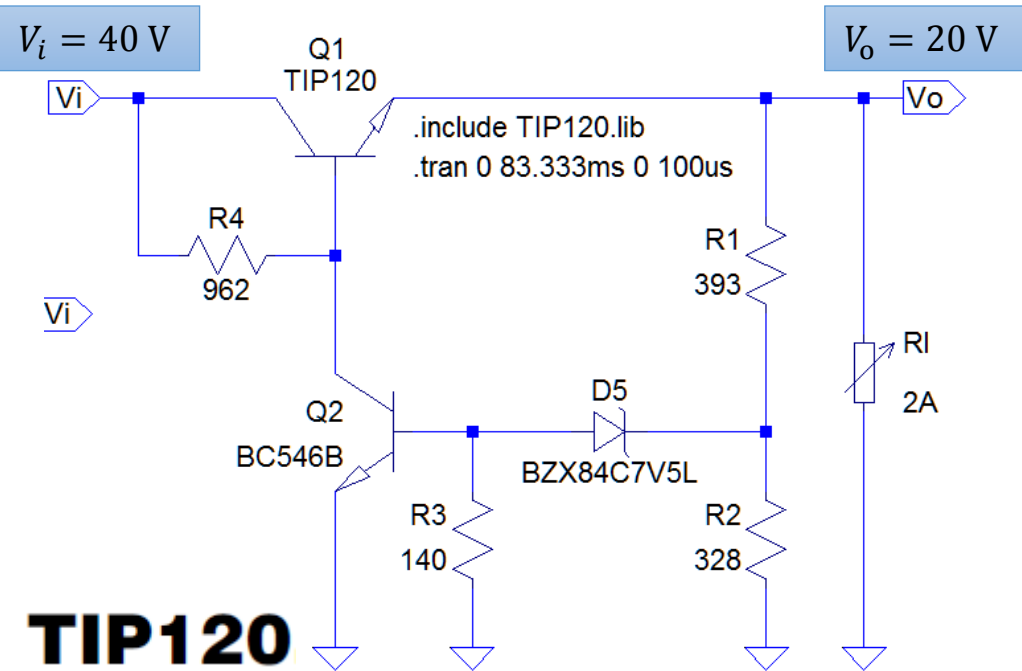
$$\Delta T = R_{\theta JA}P = 62,5 \times 40 = 2500 \text{ }^{\circ}\text{C}$$

$$T_j = \Delta T + T_a = 2500 + 25 = 2525 \text{ }^{\circ}\text{C}$$

$$R_{\theta} = \frac{\Delta T}{P}$$

$$\Delta T = T_j - T_a$$

Fonte Regulada: Temperatura da Junção com Dissipador de Calor



TIP120

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	1.92	$^{\circ}\text{C}/\text{W}$
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Operating and Storage Junction, Temperature Range	T_J, T_{stg}	-65 to +150	$^{\circ}\text{C}$

$$P = VI = (40 - 20)2 = 40 \text{ W}$$

$$R_{\theta} = \frac{\Delta T}{P}$$

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$$

$$\Delta T = T_j - T_a$$

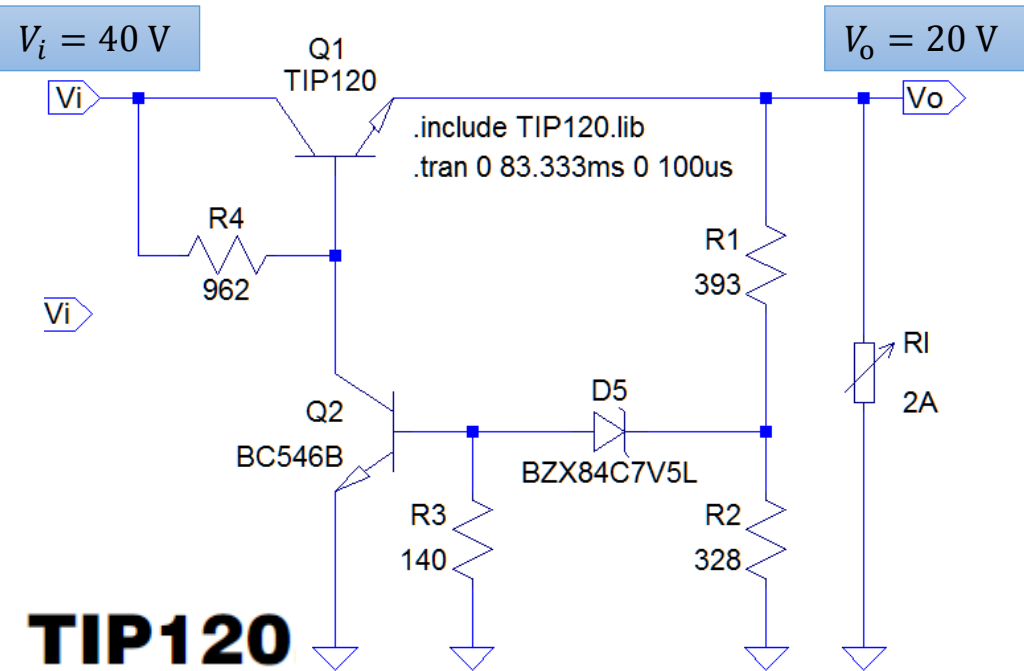
Considerando $T_a = 60^{\circ}\text{C}$:

$$R_{\theta JAmax} = \frac{T_j - T_a}{P} = \frac{150 - 60}{40} = 2,25^{\circ}\text{C}/\text{W}$$

É necessário encontrar um dissipador de calor com:

$$R_{\theta CA} = R_{\theta JAmax} - R_{\theta JC} = 2,25 - 1,92 = 0,33^{\circ}\text{C}/\text{W}$$

Fonte Regulada: Temperatura da Junção com Dissipador de Calor

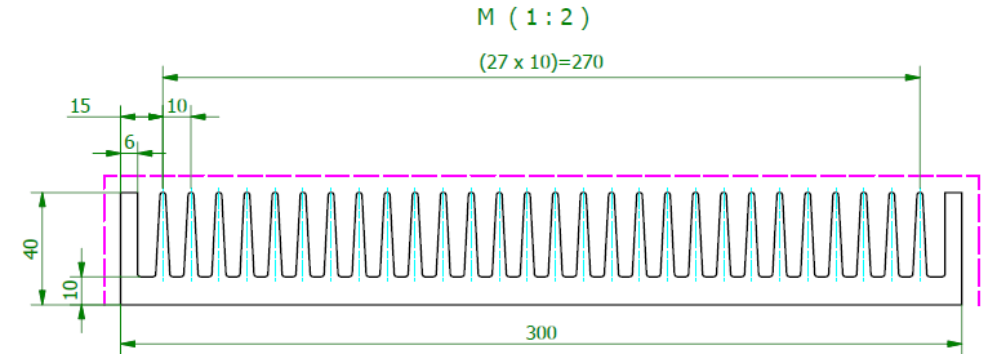


É necessário encontrar um dissipador de calor com:

$$R_{\theta CA} = R_{\theta J Amax} - R_{\theta JC} = 2,25 - 1,92 = 0,33 \text{ } ^\circ\text{C/W}$$



$$R_{\theta CA} = 0,3 \text{ } ^\circ\text{C/W}$$

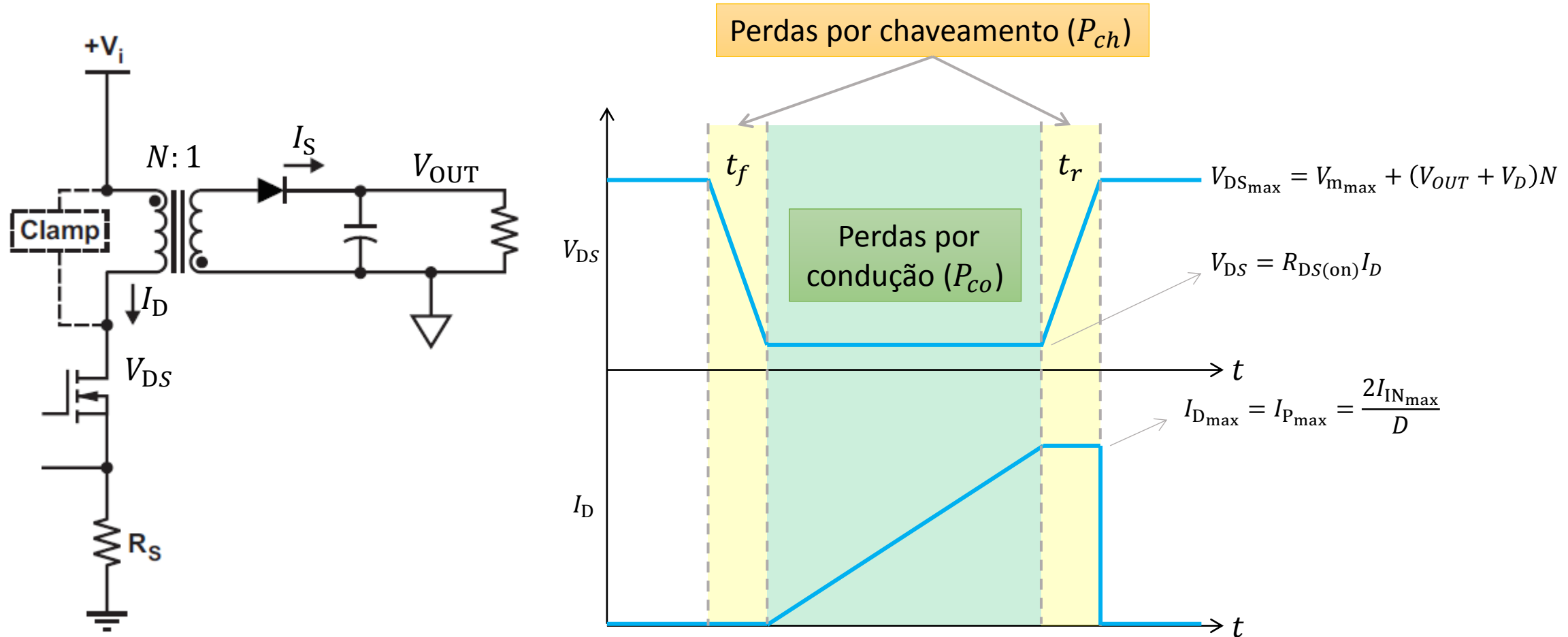


TIP120

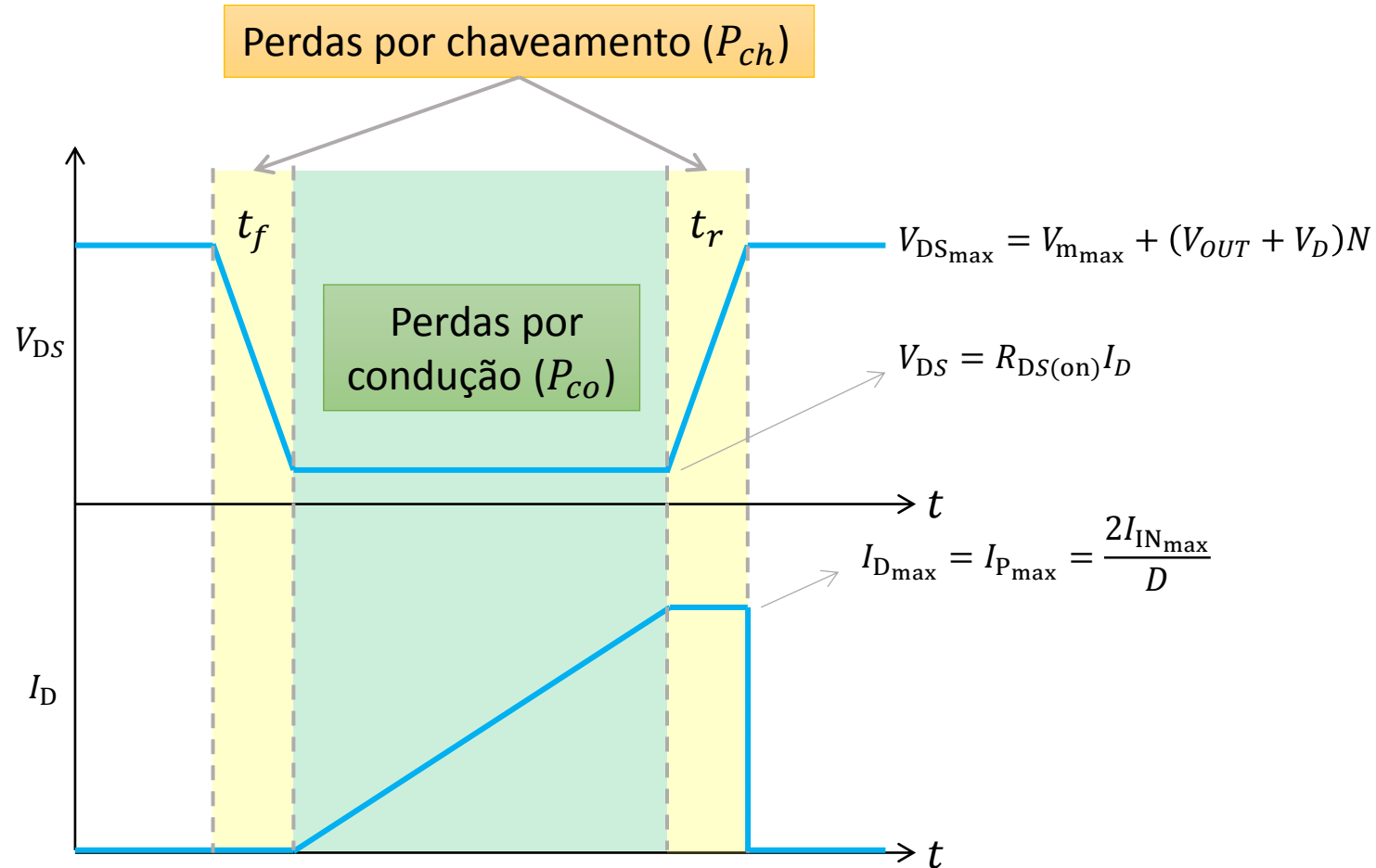
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction-to-Case	$R_{\theta JC}$	1.92	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C/W}$
Operating and Storage Junction, Temperature Range	T_J, T_{stg}	-65 to +150	$^\circ\text{C}$

Fonte Chaveada: Perdas por Condução e Chaveamento



Fonte Chaveada: Perdas por Condução e Chaveamento



Perdas por condução:

$$P_{co} = R_{DS(on)} I_{IN_{m}}^2 D$$

Perdas por chaveamento (t_r):

$$P_{ch}(t_r) = \frac{1}{2} V_{DS_{max}} I_{D_{max}} t_r f_{SW}$$

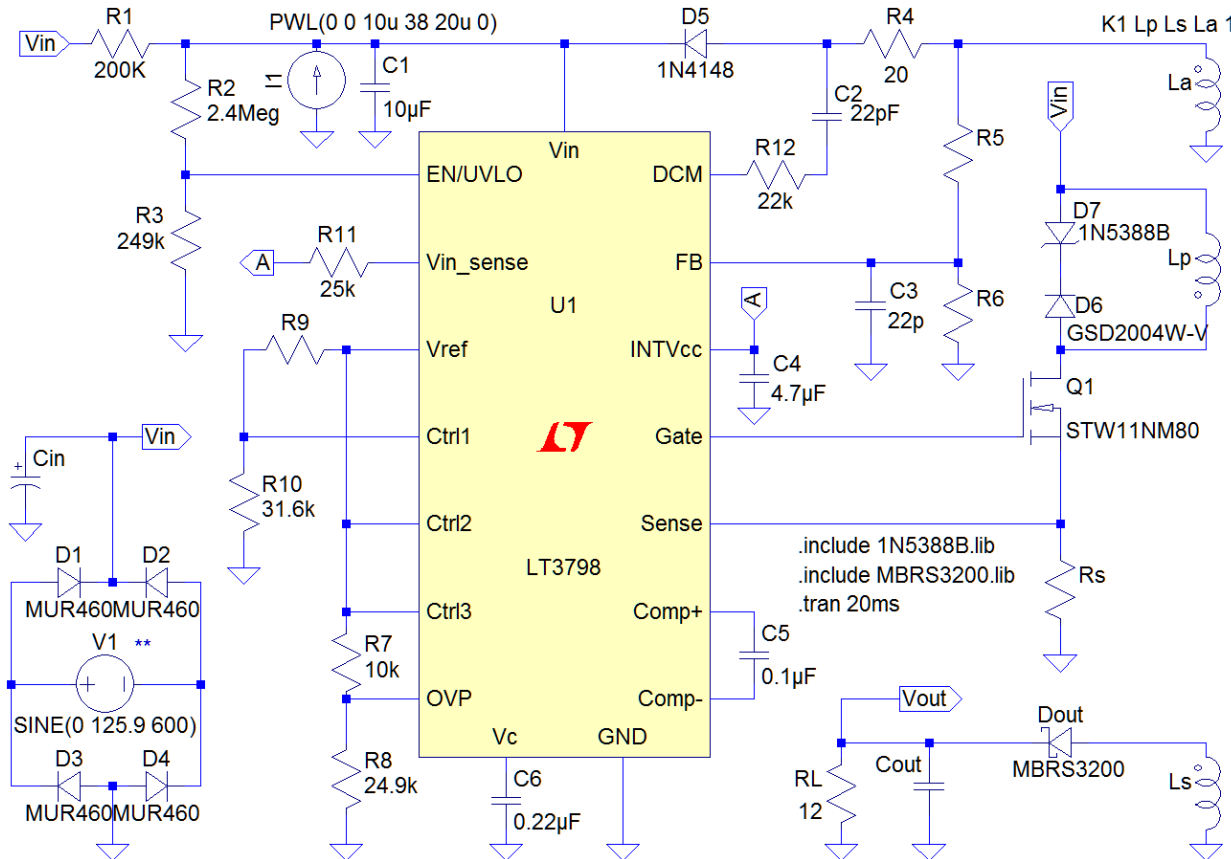
Perdas por chaveamento (t_f):

$$P_{ch}(t_f) = \frac{1}{2} V_{DS_{max}} I_{D_{max}} t_f f_{SW}$$

$$P_{ch} = P_{ch}(t_r) + P_{ch}(t_f)$$

$MT \rightarrow 0$

Fonte Chaveada: Temperatura da Junção sem Dissipador de Calor



$$D = 0,25$$

$$I_{D_{max}} = 981 \text{ mA}$$

$$V_{DS_{max}} = 410 \text{ V}$$

$$f_{SW_{max}} = 150 \text{ kHz}$$

$$I_{IN_{max}} = 122,6 \text{ mA}$$

STW11NM80

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}, I_D = 5.5 \text{ A}$		0.35	0.40	Ω
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 400 \text{ V}, I_D = 5.5 \text{ A}, R_G = 4.7 \Omega, V_{GS} = 10 \text{ V}$ (see Figure 17)		22		ns
t_r	Rise time			17		ns
$t_{d(off)}$	Turn-off delay time			46		ns
t_f	Fall time			15		ns

Perda por condução:

$$P_{CO} = 0,4 \times 0,1226^2 \times 0,25 = 1,5 \text{ mW}$$

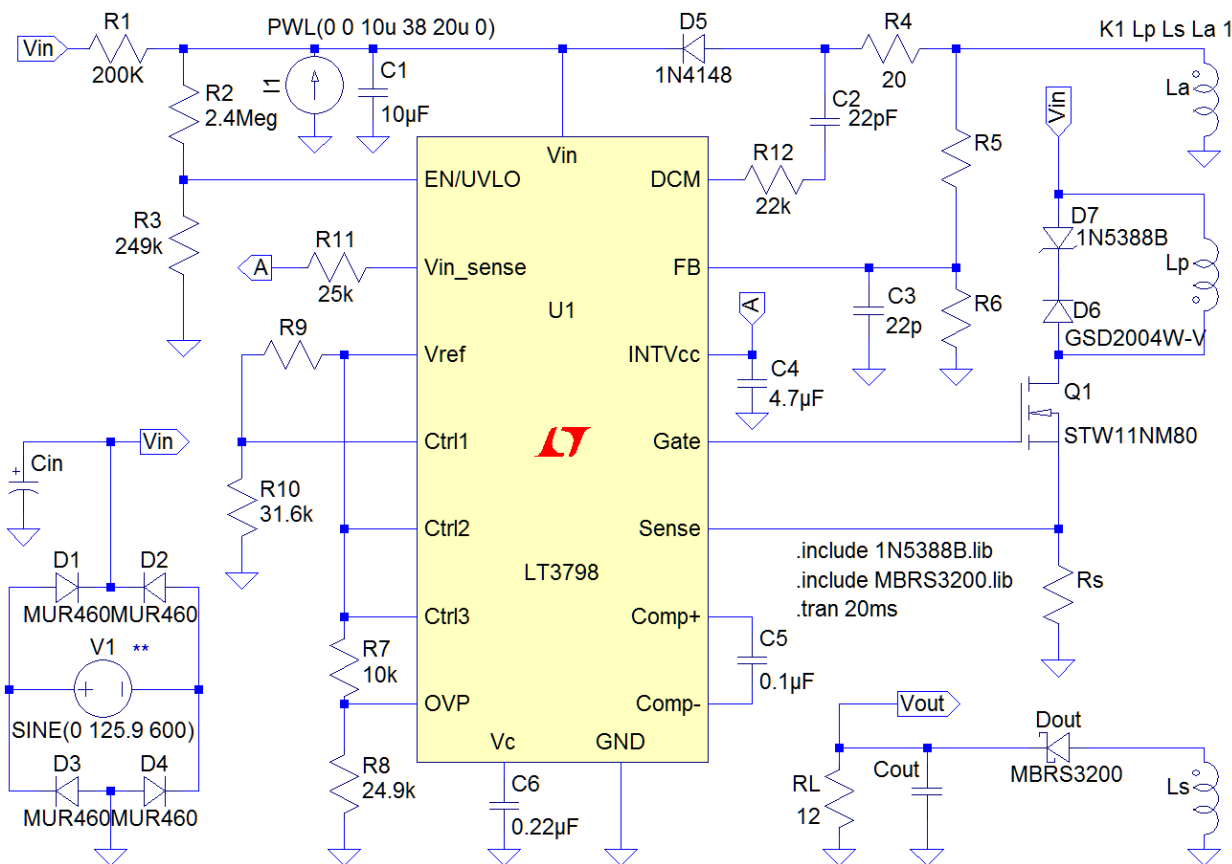
Perda por chaveamento (t_r):

$$P_{ch}(t_r) = \frac{410 \times 0,981}{2} \times 17 \times 10^{-9} \times 150 \times 10^3 = 513 \text{ mW}$$

Perda Total:

$$P_{Total} = 1,5 \text{ mW} + 513 \text{ mW} = 514,5 \text{ mW}$$

Fonte Chaveada: Temperatura da Junção sem Dissipador de Calor



$$D = 0,25$$

$$I_{D_{max}} = 981 \text{ mA}$$

$$V_{DS_{max}} = 410 \text{ V}$$

$$f_{SW_{max}} = 150 \text{ kHz}$$

$$I_{IN_{max}} = 122,6 \text{ mA}$$

Perda Total:

$$P_{Total} = 1,5 \text{ mW} + 513 \text{ mW} = 514,5 \text{ mW}$$

STW11NM80

Symbol	Parameter	Value					Unit
		D ² PAK	TO-220FP	I ² PAK	TO-220	TO-247	
$R_{thj-case}$	Thermal resistance junction-case max	0.83	3.6	0.83			°C/W
R_{thj-a}	Thermal resistance junction-ambient max			62.5	50		°C/W
T_J T_{stg}	Operating junction temperature Storage temperature			-65 to 150			°C

$$R_{\theta JA} = 50 \text{ °C/W}$$

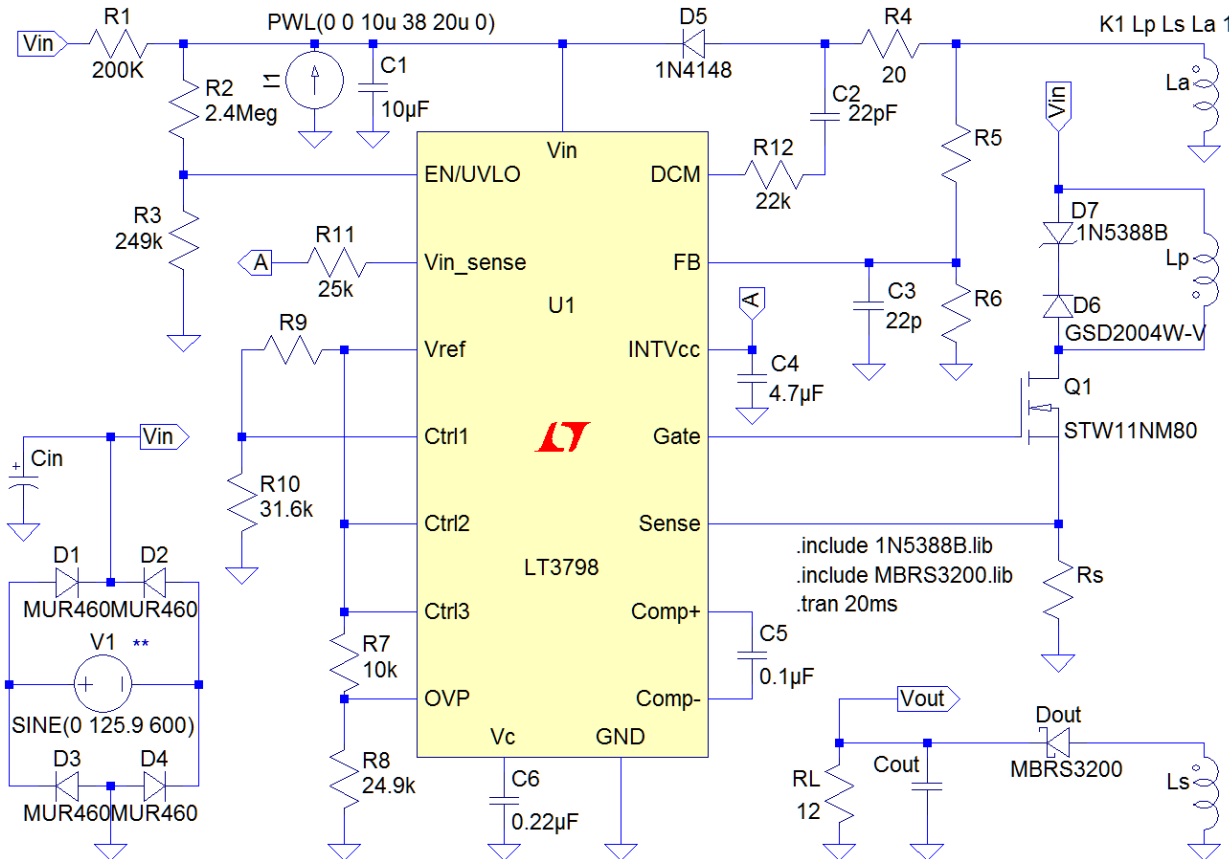
$$\Delta T = R_{\theta JA} P = 50 \times 0,5145 = 25,7 \text{ °C}$$

$$T_j = \Delta T + T_a = 25,7 + 60 = 85,7 \text{ °C}$$

$$R_{\theta} = \frac{\Delta T}{P}$$

$$\Delta T = T_j - T_a$$

Fonte Chaveada: Temperatura da Junção com Dissipador de Calor



$$D = 0,25$$

$$I_{D_{max}} = 981 \text{ mA}$$

$$V_{DS_{max}} = 410 \text{ V}$$

$$f_{SW_{max}} = 150 \text{ kHz}$$

$$I_{IN_{max}} = 122,6 \text{ mA}$$

Perda Total:

$$P_{Total} = 1,5 \text{ mW} + 513 \text{ mW} = 514,5 \text{ mW}$$

STW11NM80

Symbol	Parameter	Value					Unit
		D ² PAK	TO-220FP	I ² PAK	TO-220	TO-247	
$R_{thj-case}$	Thermal resistance junction-case max	0.83	3.6		0.83		°C/W
R_{thj-a}	Thermal resistance junction-ambient max			62.5		50	°C/W
T_j	Operating junction temperature	-65 to 150					°C
T_{stg}	Storage temperature						

Para limitar a temperatura em 70 °C:

$$R_{\theta} = \frac{\Delta T}{P}$$

$$R_{\theta JC} = 0,83 \text{ °C/W}$$

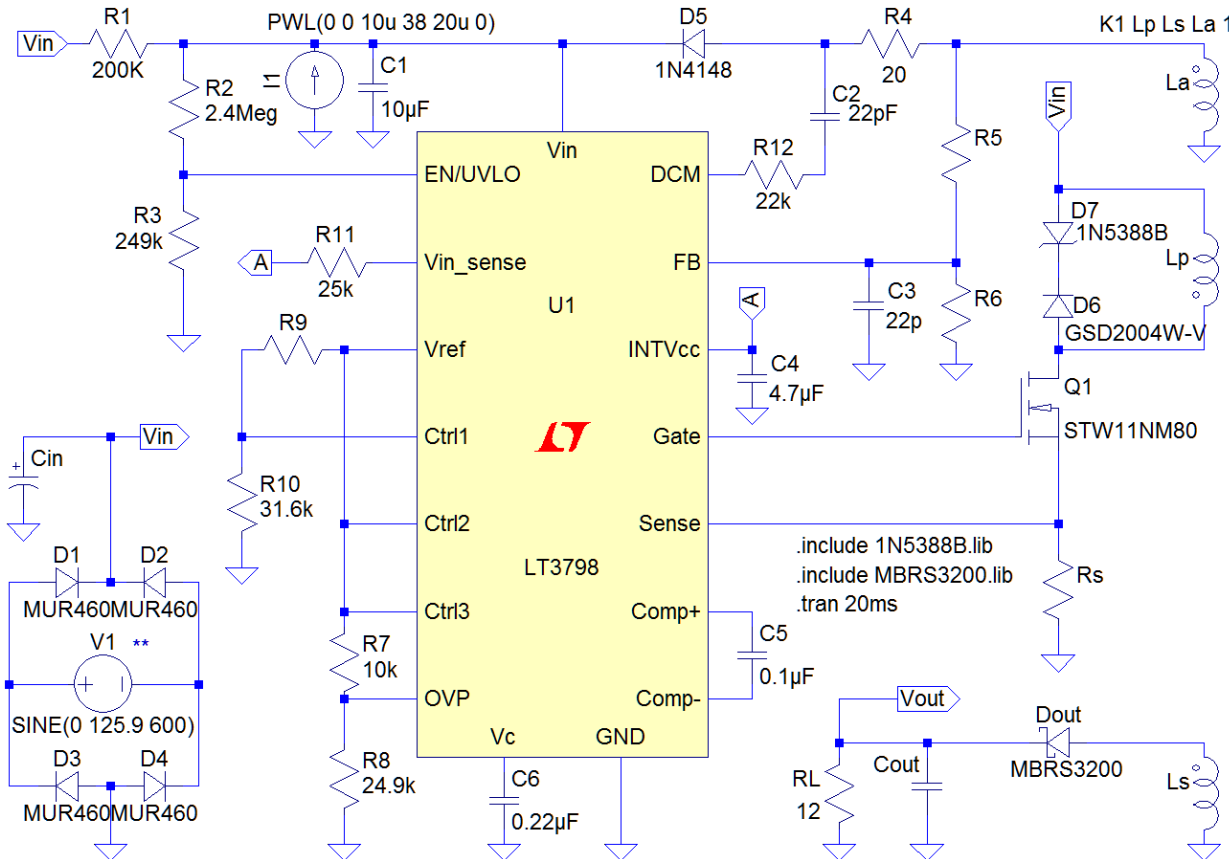
$$R_{\theta JA_{max}} = \frac{T_j - T_a}{P} = \frac{70 - 60}{0,5145} = 19,4 \text{ °C/W}$$

$$\Delta T = T_j - T_a$$

É necessário encontrar um dissipador de calor com:

$$R_{\theta CA} = R_{\theta JA_{max}} - R_{\theta JC} = 19,4 - 0,83 = 18,6 \text{ °C/W}$$

Fonte Chaveada: Temperatura da Junção com Dissipador de Calor



$$D = 0,25$$

$$I_{D_{max}} = 981 \text{ mA}$$

$$V_{DS_{max}} = 410 \text{ V}$$

$$f_{SW_{max}} = 150 \text{ kHz}$$

$$I_{IN_{max}} = 122,6 \text{ mA}$$

Para limitar a temperatura em 70 °C:

$$R_{\theta JC} = 0,83 \text{ } ^\circ\text{C/W}$$

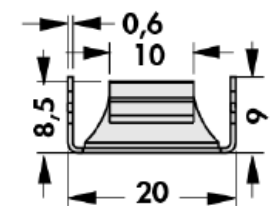
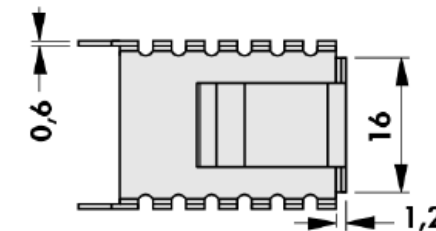
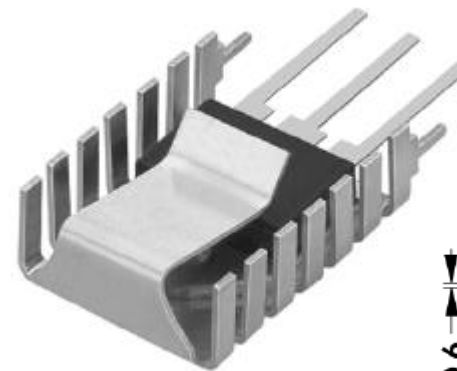
$$R_{\theta JA_{max}} = \frac{T_j - T_a}{P} = \frac{70 - 60}{0,5145} = 19,4 \text{ } ^\circ\text{C/W}$$

É necessário encontrar um dissipador de calor com:

$$R_{\theta CA} = R_{\theta JA_{max}} - R_{\theta JC} = 19,4 - 0,83 = 18,6 \text{ } ^\circ\text{C/W}$$

$$R_{\theta} = \frac{\Delta T}{P}$$

$$\Delta T = T_j - T_a$$



- ❑ Boylestad, Robert L.; Nashelsky, Louis “Dispositivos Eletrônicos e Teoria de Circuitos”, 6 ed., Rio de Janeiro, LTC (1998)
- ❑ Boylestad, Robert L.; Nashelsky, Louis “Electronic Devices and Circuit Theory”, 11 ed., Boston, Pearson (2013).