Electrónica de potencia

Examen 22/02/2017

- El examen dura **4 horas**.
- Está permitido el uso de **una** hoja de formulas y calculadora.
- Entregar los problemas en **hojas separadas**, numeradas (indicando total), con nombre y C.I.

Problema 1

Se tiene un puente seis pulsos – dos vías que está conectado a una máquina DC mediante una inductancia L, y a la red de trifásica de 230 $Vca \pm 20\,\%$, 50 Hz mediante un transformador de impedancia de cortocircuito $1j\ \Omega$ y relación de transformación unitaria. La tensión de armadura se mantendrá fija 230 Vcc (magnitud sin signo). El propósito del sistema es inyectar a la red de alterna toda la potencia que una máquina de arrastre le transmite en el eje a la máquina DC.

El puente se construye con tiristores CD431290 cuya hoja de datos se adjunta.

a) Determinar la máxima potencia que se podrá inyectar a la red sin que el puente entre en falla de conmutación, para toda condición de la red. Para esta parte puede despreciar las pérdidas de energía en el puente. **Indicar** para qué tensión de red el puente trabajará en el límite antes de que se produzca la falla de conmutación (para la potencia determinada).

b) Para plena carga y la tensión de red indicada en a), dibujar:

- Tensón en bornes de continua del puente.
- Corriente de una fase del secundario del transformador.
- Tensión de un borne de alterna del puente, respecto al neutro del sistema.

Indicar amplitudes, ángulos relevantes y en el caso de la corriente dibujar con las concavidades adecuadas. Suponer que no se entra en falla de conmutación.

c) Calcular L para asegurar conducción continua con potencias mayores al 10 % de la máxima determinada en la parte a), independientemente de la variación de la red.

d) Si se coloca cada módulo en un disipador separado, determinar la resistencia térmica máxima que puede tener cada uno de los mismos para no superar una temperatura media de juntura de 110 $°C$, teniendo una temperatura ambiente máxima de 40 $°C$.

Notas:

- Para las partes b) y d) se podrá asumir la corriente continua lisa.
- Para la parte c) se podrá despreciar la inductancia del transformador.
- En la hoja de datos $t_{off} = t_q$.

Problema 2

Se tiene un convertidor *forward* con una carga en 24 V que demanda como máximo 5 A. El mismo se alimenta de un banco de baterías cuya tensión puede variar entre 45 V y 55 V. La frecuencia de conmutación será de 50 kHz.

La cantidad de vueltas del primario y secundario es la misma, y se sabe que el núcleo disponible tiene una inductancia específica de $A_L = 1{,}2\ \frac{\mu H}{vueltas^2}$, y un flujo máximo de 26,6 μWb.

Podrán considerarse ideales a todos los dispositivos de conmutación.

a) Determinar la inductancia del filtro de salida para tener un riple de corriente no mayor a 1 App.

b) Calcular el valor mínimo para $N_p = N_s$ de modo de no superar el flujo máximo.

c) Determinar las vueltas del bobinado de desmagnetización para un correcto funcionamiento.

d) Con el fin de seleccionar el transistor necesario, indicar qué tensión y corriente instantáneas máximas deberá soportar la llave.

e) Seleccionar un condensador (o un conjunto de ellos) del catálogo adjunto para acotar el riple de tensión de salida al 2 %.

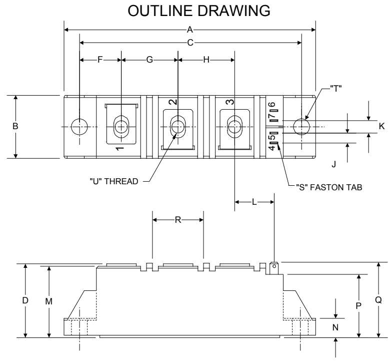
POWEREX

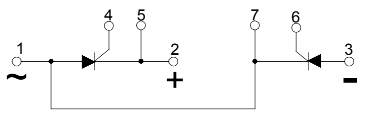
CD43__90

Powerex, Inc., Hillis Street, Youngwood, Pennsylvania 15697 (724) 925-7272

POW-R-BLOK™
Dual SCR Isolated Module
90 Amperes / Up to 1600 Volts

OUTLINE DRAWING





CONNECTION DIAGRAM

CD43__90
Dual SCR Isolated
POW-R-BLOK™ Module
90 Amperes / Up to 1600 Volts

Description:
Powerex Dual SCR Modules are designed for use in applications requiring phase control and isolated packaging. The modules are isolated for easy mounting with other components on a common heatsink. *POW-R-BLOK™* has been tested and recognized by the Underwriters Laboratories.

Features:
- Electrically Isolated Heatsinking
- DBC Alumina (Al_2O_3) Insulator
- Glass Passivated Chips
- DBC Alumina (Al_2O_3) Baseplate
- Low Thermal Impedance for Improved Current Capability
- UL Recognized (E78240)

Benefits:
- No Additional Insulation Components Required
- Easy Installation
- No Clamping Components Required
- Reduce Engineering Time

Applications:
- Bridge Circuits
- AC & DC Motor Drives
- Battery Supplies
- Power Supplies
- Large IGBT Circuit Front Ends
- Lighting Control
- Heat & Temperature Control
- Welders

CD43 Outline Dimensions

Dimension	Inches	Millimeters
A	3.62	92
B	0.81	20.5
C	3.15	80
D	1.18	30
F	0.59	15
G	0.79	20
H	0.79	20
J	0.16	4
K	0.23	5.8
L	0.61	15.5
M	1.14	29
N	0.24	6.1
P	0.94	24
Q	1.18	30
R	0.71	18
S	0.11 x .03	2.8 x 0.8
T	0.25	6.3
U	M5	M5

Note: Dimensions are for reference only

Ordering Information:
Select the complete eight digit module part number from the table below. Example: CD431690 is a 1600Volt, 90 Ampere Dual SCR Isolated *POW-R-BLOK™* Module

Type	Voltage Volts (x100)	Current Amperes (x 1)
CD43	08 12 16	90

Revision Date: 11/1/2001

Powerex, Inc., Hillis Street, Youngwood, Pennsylvania 15697 (724) 925-7272

POW-R-BLOK™
Dual SCR Isolated Module
90 Amperes / Up to 1600 Volts

Absolute Maximum Ratings

Characteristics	Conditions	Symbol		Units
Repetitive Peak Forward and Reverse Blocking Voltage		V_{DRM} & V_{RRM}	up to 1600	V
Non-Repetitive Peak Reverse Blocking Voltage (t < 5 msec)		V_{RSM}	V_{RRM} + 100	V
RMS Forward Current	180° Conduction, T_C=87°C	$I_{T(RMS)}$	140	A
	180° Conduction, T_C=87°C (AC Switch)	$I_{T(RMS)}$	200	A
Average Forward Current	180° Conduction, T_C=87°C	$I_{T(AV)}$	90	A
Peak One Cycle Surge Current, Non-Repetitive	60 Hz, 100% V_{RRM} reapplied, T_j=125°C	I_{TSM}	1570	A
	60 Hz, No V_{RRM} reapplied, T_j=125°C	I_{TSM}	1870	A
	60 Hz, No V_{RRM} reapplied, T_j=25°C	I_{TSM}	2100	A
	50 Hz, 100% V_{RRM} reapplied, T_j=125°C	I_{TSM}	1500	A
	50 Hz, No V_{RRM} reapplied, T_j=125°C	I_{TSM}	1785	A
	50 Hz, No V_{RRM} reapplied, T_j=25°C	I_{TSM}	2000	A
Peak Three Cycle Surge Current, Non-Repetitive	60 Hz, 100% V_{RRM} reapplied, T_j=125°C	I_{TSM}	1210	A
	50 Hz, 100% V_{RRM} reapplied, T_j=125°C	I_{TSM}	1155	A
Peak Ten Cycle Surge Current, Non-Repetitive	60 Hz, 100% V_{RRM} reapplied, T_j=125°C	I_{TSM}	960	A
	50 Hz, 100% V_{RRM} reapplied, T_j=125°C	I_{TSM}	940	A
I^2t for Fusing for One Cycle, 8.3 milliseconds	8.3 ms, 100% V_{RRM} reapplied, T_j=125°C	I^2t	10,270	A^2 sec
	8.3 ms, No V_{RRM} reapplied, T_j=125°C	I^2t	14,520	A^2 sec
	8.3 ms, No V_{RRM} reapplied, T_j=25°C	I^2t	18,300	A^2 sec
	10 ms, 100% V_{RRM} reapplied, T_j=125°C	I^2t	11,250	A^2 sec
	10 ms, No V_{RRM} reapplied, T_j=125°C	I^2t	15,910	A^2 sec
	10 ms, No V_{RRM} reapplied, T_j=25°C	I^2t	20,000	A^2 sec
Maximum Rate-of-Rise of On-State Current, (Non-Repetitive)	T_j=25°C, I_G=0.5 A, V_D=0.67 $V_{DRM\ (Rated)}$, I_{TM}=300A , T_r < 0.5µs, t_p > 6µs	di/dt	150	A/µs
Peak Gate Power Dissipation	T_p < 5 ms, T_j = 125°C	P_{GM}	12	W
Average Gate Power Dissipation	F = 50 Hz, T_j = 125°C	$P_{G(AV)}$	3	W
Peak Forward Gate Current	T_p < 5 ms, T_j = 125°C	I_{GFM}	3	A
Peak Reverse Gate Voltage	T_p < 5 ms, T_j = 125°C	V_{GRM}	10	V
Operating Temperature		T_J	-40 to +125	°C
Storage Temperature		T_{stg}	-40 to +125	°C
Max. Mounting Torque, M5 Mounting Screw on Terminals			25 3	in.-Lb. Nm
Max. Mounting Torque, Module to Heatsink			44 5	in.-Lb. Nm
Module Weight, Typical			83 3	g oz.
V Isolation @ 25C	50 – 60 Hz, 1 minute	V_{rms}	2500	V
Circuit to base, all terminals shorted together	50 – 60 Hz, 1 second	V_{rms}	3500	V

Revision Date: 11/1/2001

Powerex, Inc., Hillis Street, Youngwood, Pennsylvania 15697 (724) 925-7272

POW-R-BLOK™
Dual SCR Isolated Module
90 Amperes / Up to 1600 Volts

Electrical Characteristics, T_J=25°C unless otherwise specified

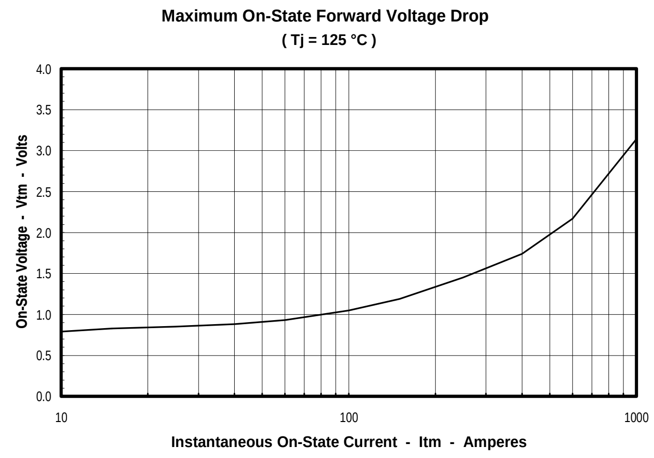
Characteristics	Symbol	Test Conditions	Min.	Max.	Units
Repetitive Peak Forward Leakage Current	I_{DRM}	Up to 1600V, T_J=125°C		15	mA
Repetitive Peak Reverse Leakage Current	I_{RRM}	Up to 1600V, T_J=125°C		15	mA
Peak On-State Voltage	V_{TM} / V_{FM}	I_{TM} / I_{FM} =300A		1.58	V
Threshold Voltage, Low-level Slope Resistance, Low-level	$V_{(TO)1}$ r_{T1}	T_J = 125°C, I = 16.7% x $\pi I_{T(AV)}$ to $\pi I_{T(AV)}$		0.80 2.40	V mΩ
Threshold Voltage, High-level Slope Resistance, High-level	$V_{(TO)2}$ r_{T2}	T_J = 125°C, I = $\pi I_{T(AV)}$ to I_{TSM}		0.85 2.25	V mΩ
V_{TM} Coefficients, Full Range		T_J = 125°C, I = 15% x $I_{T(AV)}$ to I_{TSM} V_{TM} = A+ B Ln I +C I + D Sqrt I	A = B = C = D =	0.7160 2.17E-02 2.20E-03 1.58E-03	
Minimum dV/dt	dV/dt	Linear to 2/3 V_{DRM} T_j=125°C, Gate Open Circuit	500		V/µs
Turn-Off Time (Typical)	t_{off}	T_J = 25°C, I_T = 2A V_r = 50V, -dI/dt=10 A/µs Re-Applied dV/dt = 200 V/µs, Linear to 900 V	40 - 100	(Typical)	µs
Gate Trigger Current	I_{GT}	T_j= -40°C, V_D=6V, Resistive Load T_j= 25°C, V_D=6V, Resistive Load T_j=125°C, V_D=6V, Resistive Load		270 150 80	mA mA mA
Gate Trigger Voltage	V_{GT}	T_j= -40°C, V_D=6V, Resistive Load T_j= 25°C, V_D=6V, Resistive Load T_j=125°C, V_D=6V, Resistive Load		4.0 2.5 1.7	Volts Volts Volts
Non-Triggering Gate Voltage	V_{GDM}	T_j=125°C, V_D=V_{DRM}		0.25	Volts
Non-Triggering Gate Current	I_{GDM}	T_j=125°C, V_D=V_{DRM}		6	mA
Holding Current	I_H	V_D=6V, Resistive Load, Gate Open		200	mA
Latching Current	I_L	V_D=6V, Resistive Load		400	mA

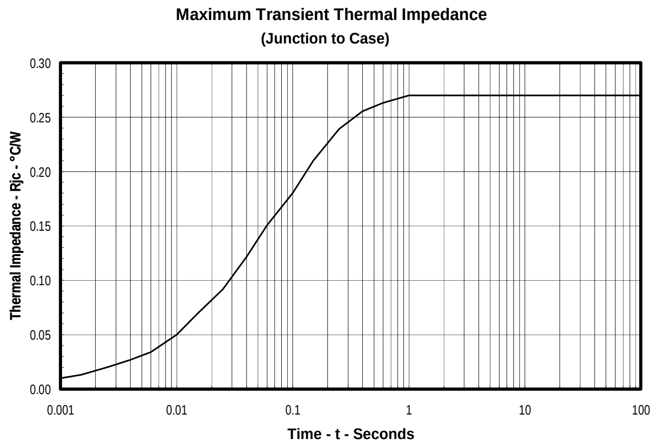
Thermal Characteristics

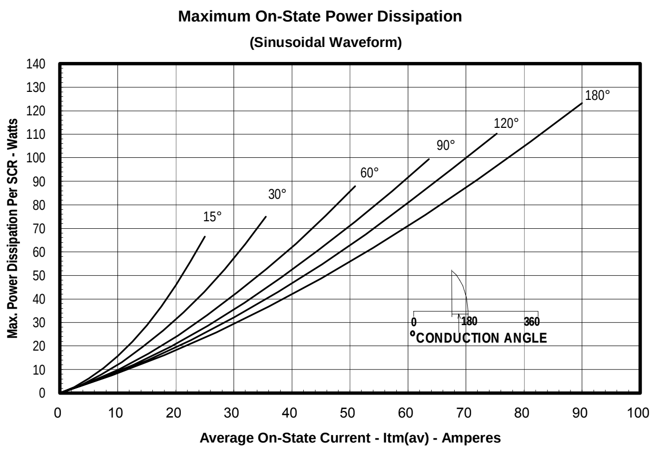
Characteristics	Symbol				Max.	Units
Thermal Resistance, Junction to Case DC Operation	$R_{\Theta J\text{-}C}$	Per Module, both conducting Per Junction, both conducting			0.135 0.270	°C/W °C/W
Thermal Impedance Coefficients	$Z_{\Theta J\text{-}C}$	$Z_{\Theta J\text{-}C}$= K_1 (1-exp(-t/τ_1)) + K_2 (1-exp(-t/τ_2)) + K_3 (1-exp(-t/τ_3)) + K_4 (1-exp(-t/τ_4))	K_1 = 6.48 E-3 K_2 = 6.02 E-2 K_3 = 1.64 E-1 K_4 = 3.94 E-2	τ_1 = 5.80 E-4 τ_2 = 1.70 E-2 τ_3 = 9.54 E-2 τ_4 = 3.53 E-1		
Thermal Resistance, Case to Sink Lubricated	$R_{\Theta C\text{-}S}$	Per Module			0.1	°C/W

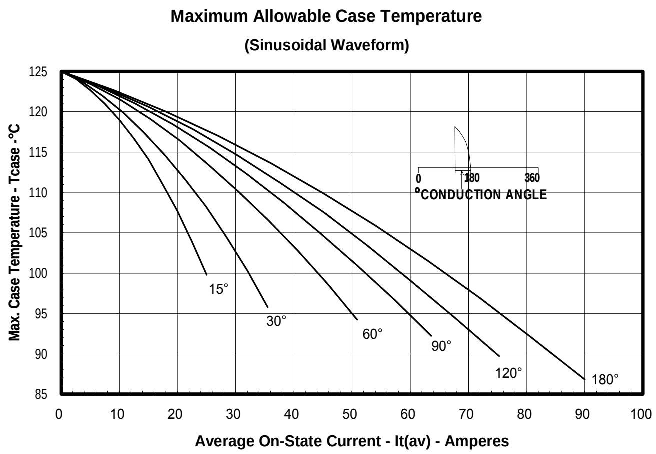
Powerex, Inc., Hillis Street, Youngwood, Pennsylvania 15697 (724) 925-7272

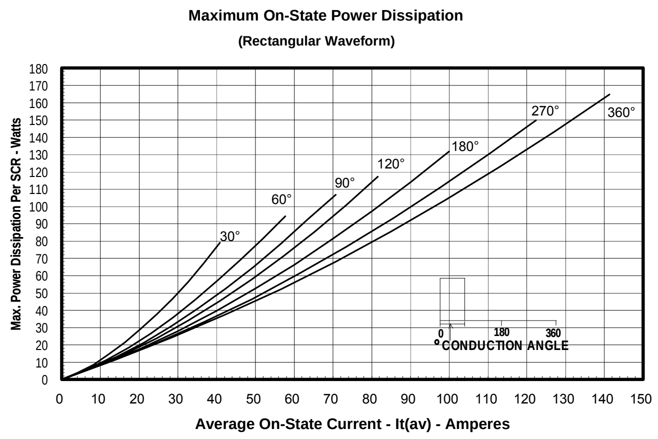
POW-R-BLOK™
Dual SCR Isolated Module
90 Amperes / Up to 1600 Volts

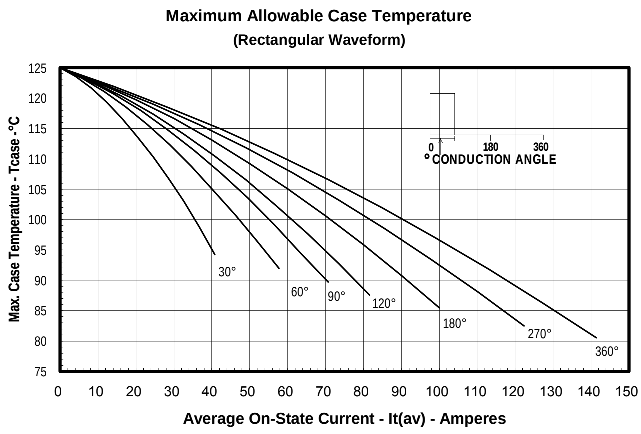


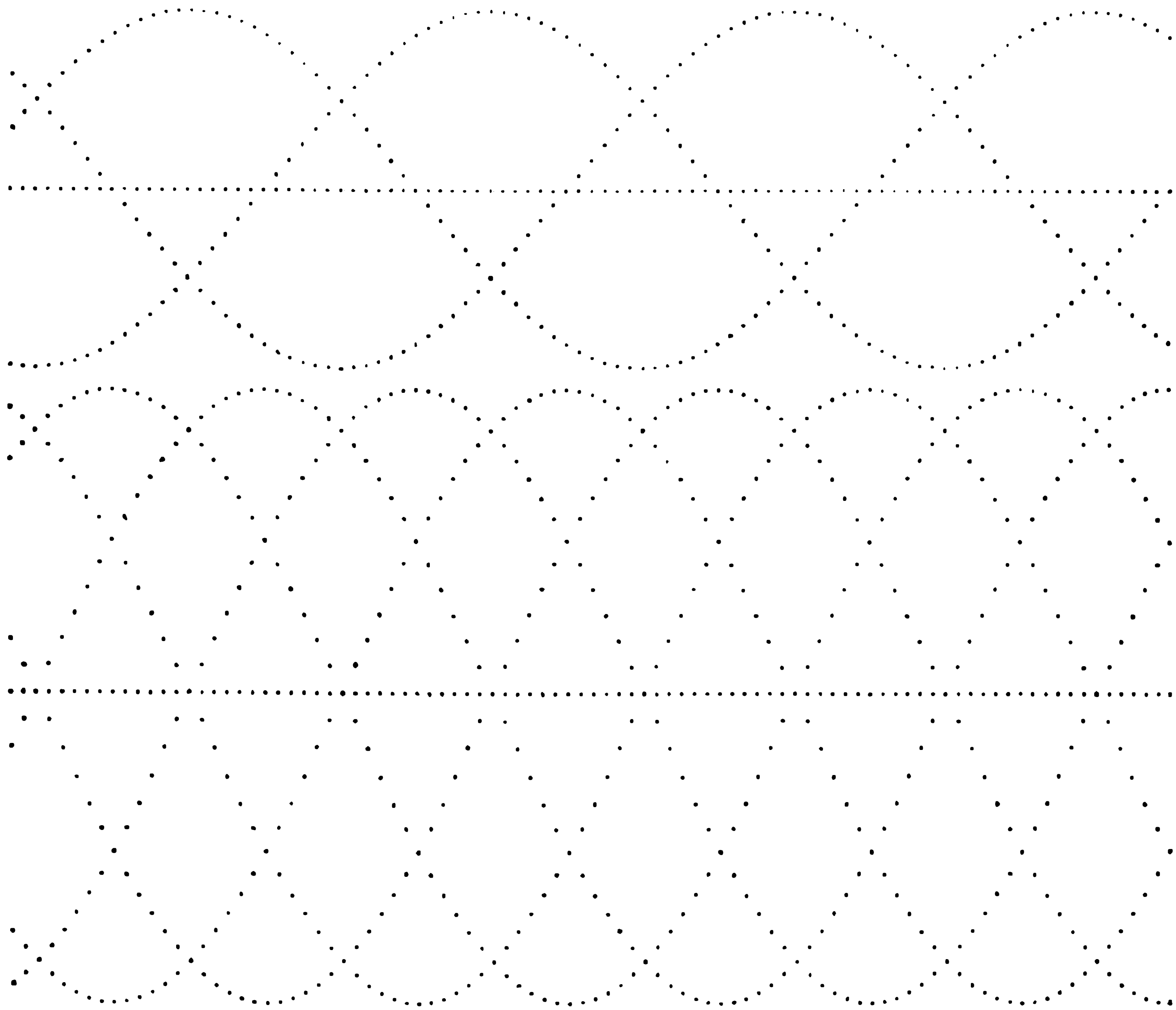


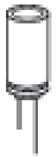












B41866

High ripple current – 125 °C

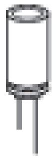
Technical data and ordering codes

C_R 120 Hz 20 °C µF	Case dimensions d × l mm	ESR_{max} 10 kHz −40 °C Ω	ESR_{max} 10 kHz 20 °C Ω	Z_{max} 100 kHz 20 °C Ω	$I_{AC,R}$ 100 kHz 125 °C mA	Ordering code (composition see below)
V_R = 25 V DC						
100	8 × 11.5	5.170	0.646	0.573	297	B41866C5107M***
120	8 × 11.5	5.170	0.646	0.573	297	B41866C5127M***
150	8 × 11.5	5.170	0.646	0.573	297	B41866C5157M***
180	8 × 11.5	5.170	0.646	0.573	297	B41866C5187M***
220	8 × 11.5	5.170	0.646	0.573	297	B41866C5227M***
270	10 × 12.5	2.980	0.373	0.336	450	B41866C5277M***
330	10 × 12.5	2.980	0.373	0.336	450	B41866C5337M***
390	10 × 16	1.404	0.175	0.160	714	B41866C5397M***
470	10 × 16	1.404	0.175	0.160	714	B41866C5477M***
560	10 × 20	1.070	0.134	0.127	875	B41866C5567M***
680	10 × 20	1.070	0.134	0.127	875	B41866C5687M***
820	12.5 × 20	0.881	0.110	0.104	1105	B41866C5827M***
1000	12.5 × 20	0.881	0.110	0.104	1105	B41866C5108M***
1200	12.5 × 25	0.710	0.089	0.082	1358	B41866C5128M***
1500	12.5 × 25	0.710	0.089	0.082	1358	B41866C5158M***
1800	16 × 20	0.401	0.050	0.046	1895	B41866C5188M***
2200	12.5 × 40	0.406	0.051	0.047	2185	B41866C5228M***
2200	16 × 25	0.314	0.039	0.037	2279	B41866D5228M***
2200	18 × 20	0.341	0.043	0.040	2190	B41866E5228M***
2700	18 × 25	0.312	0.039	0.037	2454	B41866D5278M***
3300	16 × 31.5	0.248	0.031	0.029	2822	B41866D5338M***
3900	16 × 35.5	0.200	0.025	0.024	3230	B41866E5398M***
3900	18 × 31.5	0.224	0.028	0.027	3178	B41866D5398M***
4700	18 × 35	0.184	0.023	0.022	3638	B41866D5478M***
5600	18 × 40	0.152	0.019	0.018	4244	B41866C5568M***

Composition of ordering code

*** = Version

000 = for standard leads, bulk
001 = for kinked leads, bulk (for d × l = 10 × 20 … 12.5 × 25 mm and ∅ 16 … 18 mm)
002 = for cut leads, bulk (for ∅ 10 ... 18 mm, excluding d × l = 12.5 × 40 mm)
003 = for crimped leads, blister (for ∅ 16 … 18 mm)
004 = for J leads, blister (for ∅ 10 ... 18 mm, excluding d × l = 12.5 × 40 and 18 × 40 mm)
006 = for taped leads, Ammo pack, lead spacing F = 3.5 mm (for ∅ 8 mm)
008 = for taped leads, Ammo pack, lead spacing F = 5.0 mm (for d × l = 8 × 11.5 … 12.5 × 25 mm)
009 = for taped leads, Ammo pack, lead spacing F = 7.5 mm (for d × l = 16 × 20 … 16 × 31.5 mm and 18 × 20 … 18 × 31.5 mm)
012 = for bent 90° leads, blister (for ∅ 16 ... 18 mm)



B41866

High ripple current – 125 °C

Technical data and ordering codes

C_R 120 Hz 20 °C µF	Case dimensions d × l mm	ESR_{max} 10 kHz –40 °C Ω	ESR_{max} 10 kHz 20 °C Ω	Z_{max} 100 kHz 20 °C Ω	$I_{AC,R}$ 100 kHz 125 °C mA	Ordering code (composition see below)
V_R = 50 V DC						
47	8 × 11.5	5.687	0.711	0.631	370	B41866C6476M***
56	8 × 11.5	5.429	0.679	0.602	370	B41866C6566M***
68	8 × 11.5	5.170	0.646	0.573	370	B41866C6686M***
82	8 × 11.5	5.170	0.646	0.573	370	B41866C6826M***
100	10 × 12.5	2.980	0.373	0.336	450	B41866C6107M***
120	10 × 16	1.404	0.175	0.160	714	B41866C6127M***
150	10 × 16	1.404	0.175	0.160	714	B41866C6157M***
180	10 × 20	1.070	0.134	0.127	875	B41866C6187M***
220	10 × 20	1.070	0.134	0.127	875	B41866C6227M***
270	10 × 20	1.070	0.134	0.127	875	B41866C6277M***
330	12.5 × 20	0.881	0.110	0.104	1105	B41866C6337M***
390	12.5 × 25	0.710	0.089	0.082	1358	B41866C6397M***
470	12.5 × 25	0.710	0.089	0.082	1358	B41866C6477M***
470	16 × 20	0.680	0.085	0.080	1370	B41866D6477M***
560	16 × 20	0.401	0.050	0.046	1895	B41866C6567M***
680	16 × 25	0.314	0.039	0.037	2279	B41866C6687M***
820	16 × 25	0.314	0.039	0.037	2279	B41866C6827M***
820	18 × 20	0.344	0.043	0.040	2190	B41866E6827M***
1000	16 × 31.5	0.249	0.031	0.029	2822	B41866C6108M***
1000	18 × 25	0.314	0.039	0.037	2454	B41866D6108M***
1200	16 × 35.5	0.200	0.025	0.024	3230	B41866D6128M***
1200	18 × 31.5	0.226	0.028	0.027	3178	B41866C6128M***
1500	18 × 35	0.187	0.023	0.022	3638	B41866C6158M***
1800	18 × 40	0.153	0.019	0.018	4244	B41866C6188M***

Composition of ordering code

*** = Version

000 = for standard leads, bulk
001 = for kinked leads, bulk (for d × l = 10 × 20 … 12.5 × 25 mm and ∅ 16 … 18 mm)
002 = for cut leads, bulk (for ∅ 10 ... 18 mm, excluding d × l = 12.5 × 40 mm)
003 = for crimped leads, blister (for ∅ 16 … 18 mm)
004 = for J leads, blister (for ∅ 10 ... 18 mm, excluding d × l = 12.5 × 40 and 18 × 40 mm)
006 = for taped leads, Ammo pack, lead spacing F = 3.5 mm (for ∅ 8 mm)
008 = for taped leads, Ammo pack, lead spacing F = 5.0 mm (for d × l = 8 × 11.5 … 12.5 × 25 mm)
009 = for taped leads, Ammo pack, lead spacing F = 7.5 mm (for d × l = 16 × 20 … 16 × 31.5 mm and 18 × 20 … 18 × 31.5 mm)
012 = for bent 90° leads, blister (for ∅ 16 ... 18 mm)

Examen Electrónica de Potencia

22/02/2017

Problema 1

a) Para una tensión de red dada la corriente límite va a estar dada por

$$\gamma = \gamma_{min} = \frac{100\mu s}{20ms} \cdot 360° = 1,8° \quad (t_q = 100\mu s)$$

$$\Rightarrow -U_d = \frac{3}{\pi}\sqrt{2}U\cos\gamma_{min} - \frac{3}{\pi}X_{cc}I$$

$$\Rightarrow I = \frac{1}{X_{cc}} \cdot \left\{ \frac{\pi}{3}U_d + \sqrt{2} \cdot U \cdot \cos\gamma_{min} \right\}$$

El valor mínimo que corresponde a $U = U_{min}$ es el que puedo asegurar para todo punto de operación.

$$I = 19,23\ A \quad (\text{con } U = 0,8 \cdot 230V)$$

que corresponde a $P = 19,23A \cdot 230V = 4423W$

Con esta corriente máxima se estará en el límite de falla de conmutación si $U = U_{min}$.

Problema 1 (cont.)

b) $$\alpha = \cos^{-1}\left\{\left(U_d + \frac{3}{\pi} X_{cc} I\right) \frac{\pi}{3\sqrt{2}\, U_{min}}\right\} = 148,4^\circ.$$

$$\mu = 180^\circ - \alpha - \gamma_{min} = 29,8^\circ.$$

Ver papel trifásico.

c) El rizado de corriente se maximiza con el α menor, es decir con $U = U_{máx}$.
Desprecio el efecto de la conmutación.

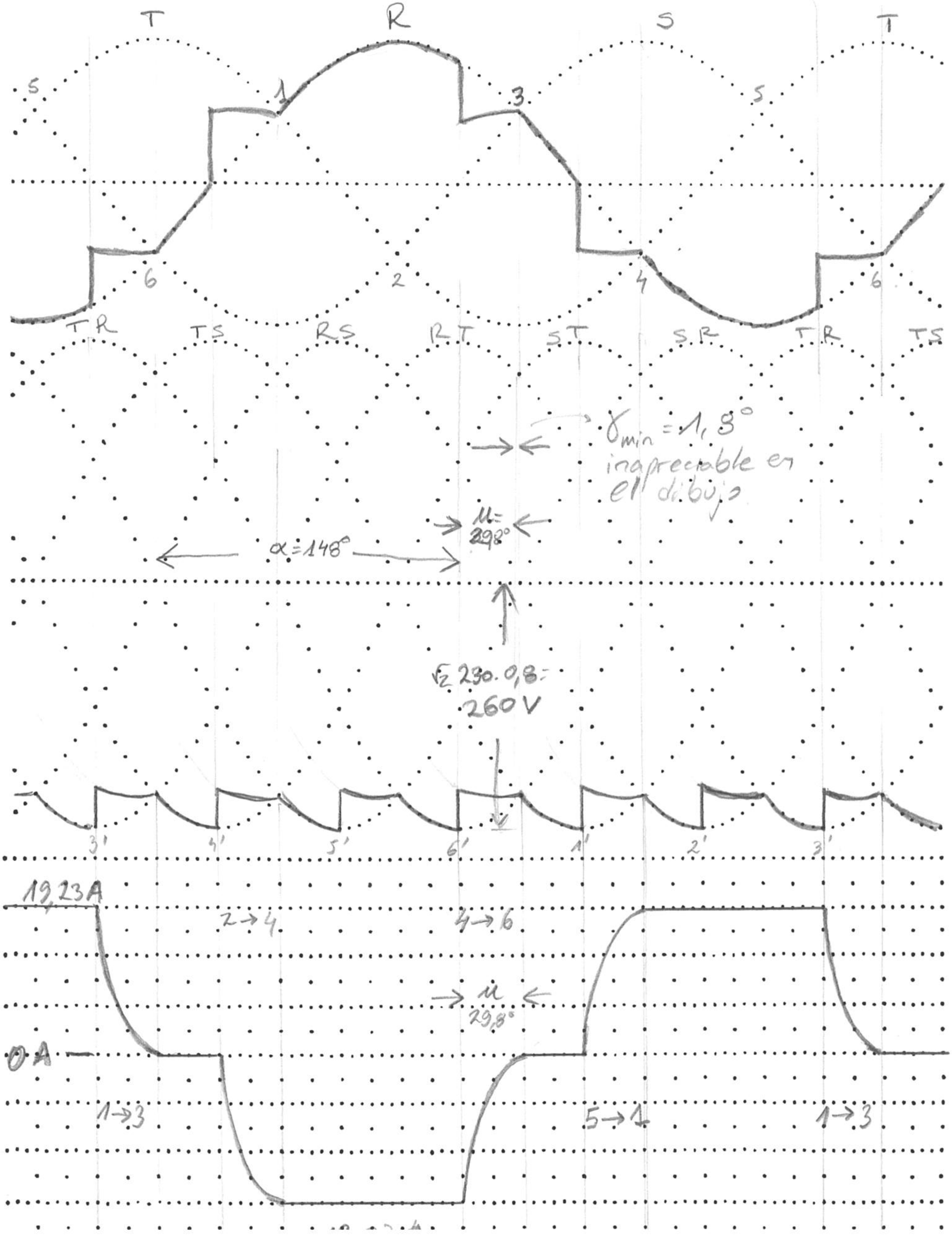
$$\cos \alpha_0 = \frac{U_d}{\frac{3}{\pi}\sqrt{2}\, U_{máx}} \Rightarrow \alpha_0 = 123,1^\circ.$$

$$I_{Lcc0} \approx \frac{1}{3} \frac{U_{máx}}{L\omega} \cdot \text{sen}\, \alpha_0 < 1,923\,A.$$

$$\Rightarrow L > \frac{1}{3} \cdot \frac{1,2 \cdot 230\,V}{1,923\,A \cdot 2\pi \cdot 50\,Hz} \cdot \text{sen}\,123,1^\circ = 44,94\,mH$$

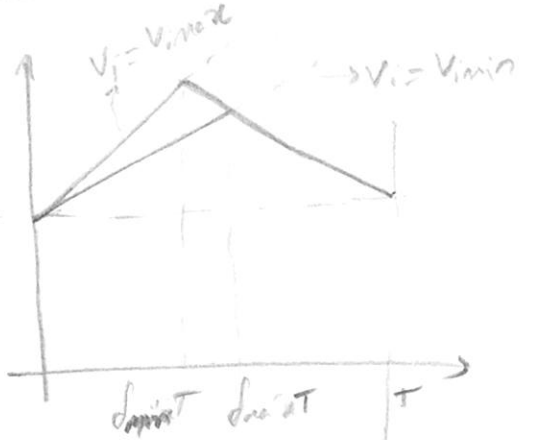
d) $$\underset{\text{por módulo}}{\langle P \rangle} = 2 \underset{\text{por tiristor}}{\langle P \rangle} = 2 \cdot \frac{1}{3}\left(r_T \cdot I + V_{T0}\right) I = 10,8\,W$$

$$R_{sa} < \frac{110^\circ C - 40^\circ C}{10,8\,W} - \underset{\text{por módulo}}{\overset{0,135\,^\circ C/W}{R_{jc}}} - \underset{\text{por módulo}}{\overset{0,1\,^\circ C/W}{R_{cs}}} = 6,217\,^\circ C/W.$$


T
R
S
T
1
3
6
2
4
6
TR
TS
RS
RT
ST
SR
TR
TS
γmin = 1,8°
inapreciable en el dibujo
u = 29,8°
α = 148°
√2 230 · 0,8 =
260 V
3'
4'
5'
6'
1'
2'
3'
19,23A
2→4
4→6
u
29,8°
0 A
1→3
5→1
1→3

Problema 2

a)

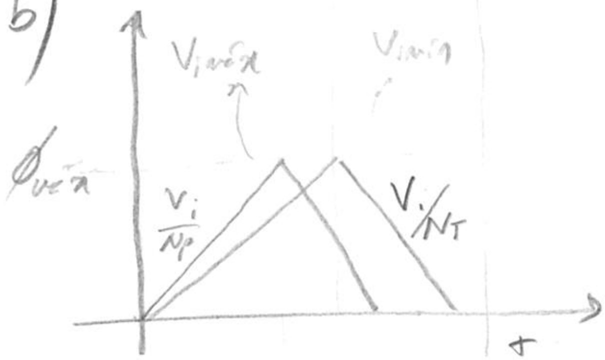


$$\Delta I_L = \frac{V_i - V_o}{L} \cdot \delta T \Big|_{V_i = V_{imax}}$$

$$= \frac{55V - 24V}{L \cdot 50kHz} \cdot \frac{24V}{55V} < 1A$$

$$\Rightarrow L > 271\ \mu H.$$

b)



$$\hat{\phi} = \frac{V_i \delta T}{N_p}$$

$$\hat{\phi} = \frac{V_i}{N_p f} \cdot \frac{V_o}{V_i} < \phi_{max}$$

$$\Rightarrow N_p > \frac{V_o}{\phi_{max} \cdot f} = 18,045$$

$$\therefore \boxed{N_p = 19 \text{ vueltas}}$$

c) Peor caso: δ_{max}, V_{imin}

$$D \cdot T \cdot \frac{V_i}{N_T} = \phi_{max} = \frac{V_i \delta T}{N_p} \Rightarrow D = \frac{N_T}{N_p} \cdot \delta < 1 - \delta$$

$$\Rightarrow N_T < \left(\frac{1}{\delta} - 1\right) N_p = \left(\frac{45V}{24V} - 1\right) 19 \text{ vueltas} = 16,625$$

$$\therefore \boxed{N_T = 16 \text{ vueltas}}$$

Problema 2 (cont.)

d) $U_{Q\,máx} = V_{i\,máx}\left(1+\frac{N_P}{N_T}\right) = 55V\left(1+\frac{19}{16}\right) = 120{,}3\ V$

$I_{Q\,máx} = \max_{V_i}\left\{\hat{I}_S + \hat{I}_m\right\}$

$\hat{I}_m = \frac{V_i}{L_P}\cdot\delta T = \frac{V_i}{L_P f}\frac{V_o}{V_i} = \frac{V_o}{L_P f}$ || $L_P = A_L N_P^2 = 44{,}76\ \mu H$

$\Rightarrow \hat{I}_m = 1{,}108\ A$ (no depende de V_i).

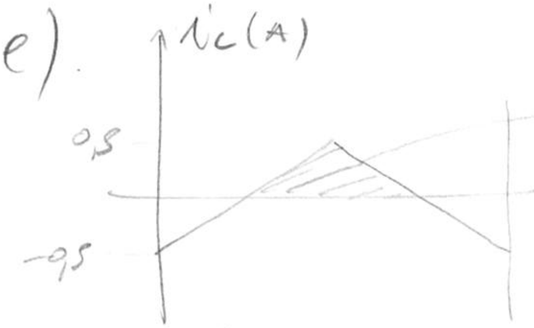
$\hat{I}_S = I_{o\,máx} + \frac{1}{2}\Delta I_{L\,máx}$

Asumiendo $L = 271\ \mu H \Rightarrow \Delta I_L = 1A$

$\hat{I}_S = 5A + 0{,}5A = 5{,}5A$.

$\therefore I_{Q\,máx} = 6{,}608\ A$

e)



$\rightarrow Q = \frac{\Delta I_L}{2}\cdot\frac{T}{2}\cdot\frac{1}{2} = \frac{1A}{8f} = 2{,}5\ \mu C$

$24V \cdot 0{,}02 = 480\ mV$

→ Tomo factor de seguridad 2 → V = 50 V

→ Si sólo estuviera el efecto capacitivo necesitaría

$C > \frac{2{,}5\ \mu C}{480\ mV} = 5{,}2\ \mu F$ << a cualquiera de los disponibles. Elijo el de $ESR = 0{,}401\Omega$ @-40°C de modo que $\Delta V = 0{,}401\Omega \cdot 1A = 401\ mV < 480\ mV$.

Desprecio la componente capacitiva pues $\frac{2{,}5\ \mu C}{560\ \mu F} = 4\ mV \ll 401\ mV$

• 50V, 560 μF