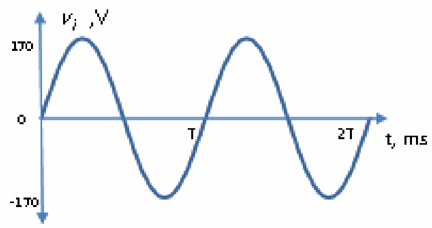
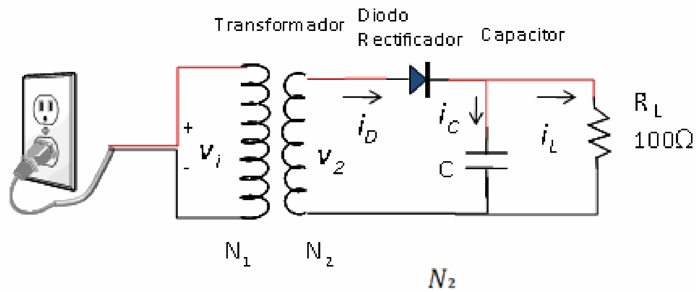
Aplicaciones con diodos

Fuentes de Voltaje no Reguladas



$$v_i = 170\,\text{sen}\,\omega t$$

$$\omega = 2\pi f \quad f = {}^{1}/_{T} = 60\ Hz$$



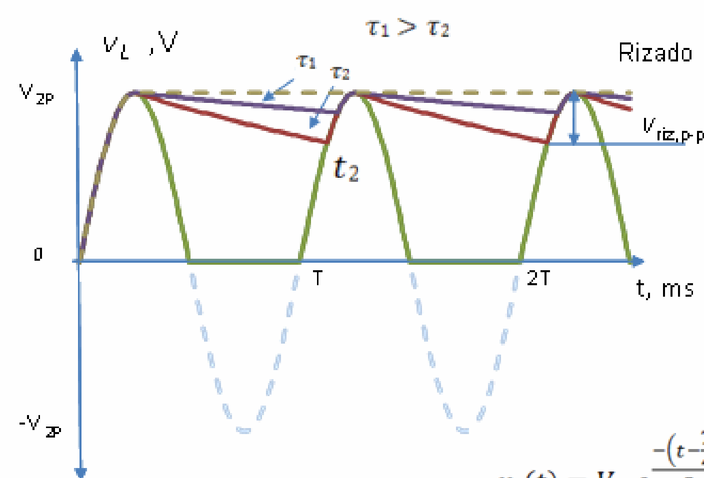
$$v_2 = \frac{N_2}{N_1} v_i$$

Valor medio (Valor DC):

$$v_{DC} = \overline{v} = \frac{1}{T}\int^{T} v_i(t)\ dt$$

Valor RMS:

$$v_{AC} = \sqrt{\frac{1}{T}\int^{T} v_i(t)^2\ dt}$$



$$v_C(t) = V_{2P} e^{\frac{-\left(t-\frac{T}{4}\right)}{\tau}}$$

$$\tau = R_L C$$

$$v_{\text{riz,p-p}}(t_2) = V_{2P}\left(1 - e^{-\frac{T}{\tau}}\right)$$

$$v_{\text{riz,p-p}} \approx \frac{V_{2P}}{f R_L C}$$

Series de Taylor:

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \quad \text{para todo } x$$

$$e^x \approx 1 + x \quad si\ x \ll 1$$

$$e^{-\frac{T}{\tau}} = 1 - \frac{T}{\tau} \quad con\ \frac{T}{\tau} \ll 1$$

$t_2 = \frac{5T}{4}, \tau = \propto$	$v_{\text{riz,p-p}}$	$t_2 \to \frac{5T}{4}$	$\frac{V_{2P}}{f R_L C}$
$t_2 = \frac{75T}{64}, \tau_1 = 0{,}122$			
$t_2 = \frac{72T}{64}, \tau_2 = 0{,}042$			

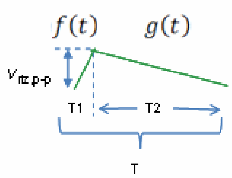
Valor DC de la carga

$$v_{L,DC} = \frac{1}{T}\left(\int_{\frac{T}{4}}^{t2} V_{2P} e^{\frac{-\left(t-\frac{T}{4}\right)}{\tau}} dt + \int_{t2}^{\frac{5T}{4}} V_{2P} \operatorname{sen}\frac{2\pi}{T} t \, dt\right)$$

$$v_{L,DC} = V_{2P} - \frac{v_{\text{riz,p-p}}}{2}$$

	$V_{L,DC}$ $t_2 \rightarrow \frac{5T}{4}$ $\frac{V_{2P}}{f R_L C}$
$t_2 = \frac{5T}{4}$, $\tau = \propto$	
$t_2 = \frac{75T}{64}$, $\tau_1 =$ 0,122	
$t_2 = \frac{72T}{64}$, $\tau_2 =$ 0,042	

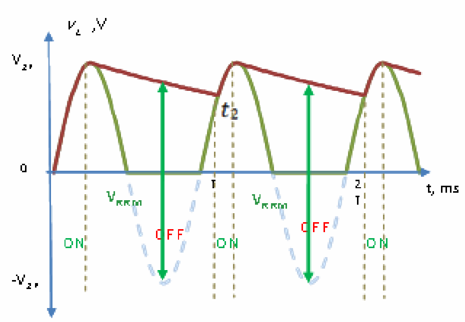
Valor RMS del rizado:

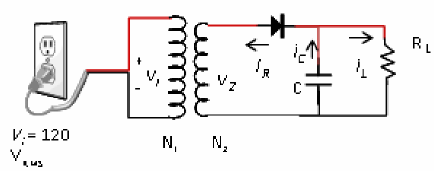


$$f(t) = v_{\text{riz,p-p}} \frac{t}{T1}$$

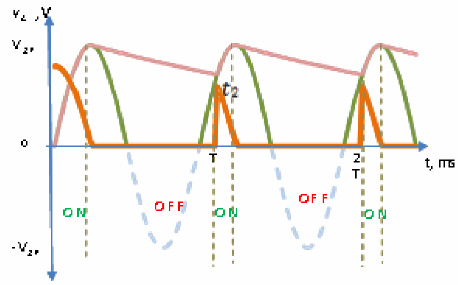
$$g(t) = v_{\text{riz,p-p}} \frac{T2 - t}{T2}$$

Voltaje Pico Inverso Recurrente y la máxima corriente en contra





Cálculo de la corriente del diodo a favor



$I_F = I_C + I_L$ $\qquad I_C = C\dfrac{dV_C}{dt}$ $\qquad I_L = \dfrac{V_L}{R_L}$ $\qquad V_C = V_L$

$I_F = C\dfrac{dV_L}{dt} + \dfrac{V_L}{R_L}$ $\qquad$ diodo ON $\Rightarrow V_L = V_{2P}\,\text{sen}\,\dfrac{2\pi}{T}t$

$I_F = 2\pi f C V_{2P}\cos\dfrac{2\pi}{T}t + \dfrac{V_{2P}}{R_L}\text{sen}\,\dfrac{2\pi}{T}t$

$$\left.\begin{aligned} K\,\text{sen}\,\varphi &= 2\pi f C \\ K\cos\varphi &= \frac{1}{R_L}\end{aligned}\right\} \quad I_F = V_{2P}\,K\,\text{sen}\,\varphi\cos\frac{2\pi}{T}t + V_{2P}\,K\cos\varphi\,\text{sen}\,\frac{2\pi}{T}t$$

$$K^2\sin^2\varphi + K^2\cos^2\varphi = (2\pi f C)^2 + \left(\frac{1}{R_L}\right)^2 = K^2$$

$I_F = V_{2P}\,K\,\text{sen}\left(\dfrac{2\pi}{T}t + \varphi\right)$

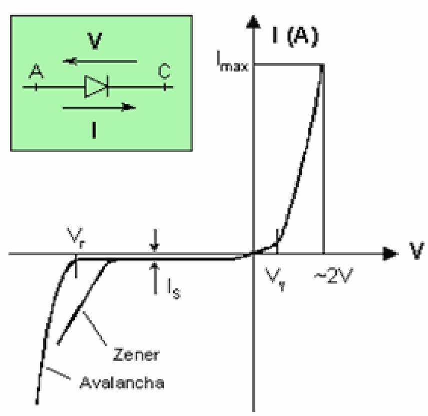
$K = \sqrt{(2\pi f C)^2 + \left(\dfrac{1}{R_L}\right)^2}$

$\tan\varphi = 2\pi f C R_L$

Corriente Pico a Favor Recurrente $\qquad I_{FRM} = V_{2P}\,K\,\text{sen}\left(\dfrac{2\pi}{T}t2 + \varphi\right)$

Sobrecorriente Pico a Favor $\qquad I_{FSM} \approx V_{2P}\,K$

Corriente a Favor Promedio $\qquad I_{F(AV)} = \dfrac{V_{2P}\,K}{T}\displaystyle\int_{t2}^{\frac{5T}{4}} \text{sen}\left(\dfrac{2\pi}{T}t + \varphi\right)dt$



Modelo Shockley:

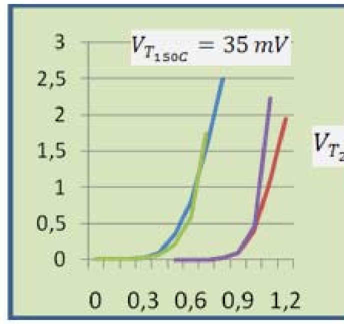
$$I_D = I_R\left(e^{\frac{V_D}{\eta V_T}} - 1\right) \qquad V_T = \frac{kT}{q},$$

q: carga del electrón: 1.6 * 10^{-19}
T: temperatura absoluta de la unión
k: constante Boltzmann $k \approx 1.3806503 \times 10^{-23} J/K$
n: es el coeficiente de emisión, dependiente del proceso de fabricación del diodo y que suele adoptar valores entre 1 (para el germanio) y del orden de 2 (para el silicio).

El término VT = kT/q = T/11600 es la tensión debida a la temperatura, del orden de *25 mV* a temperatura ambiente (300 K ó 25 ºC).

Curva Característica del Diodo

$$I_D = 0.1\,x\,10^{-6}\,e^{\frac{V_D}{2.6V_T}} \qquad V_{T_{25C}} = 25\ mV$$



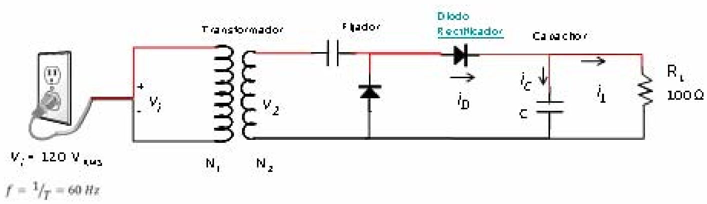
Rthj-a: Resistencia térmica entre la unión y el ambiente

$$T_J \propto P_D$$

$$P_D = \frac{T_J - T_a}{R_{thj-a}}$$

Si el diodo 1N5390 tiene una corriente de 1 A y en su superficie se tiene 25 °C ¿Cuál sería la temperatura en la unión?

Fuente duplicadora de voltaje:



Conservación de la energía:

$$Vc_1 + Vc_2 = cte \Rightarrow$$

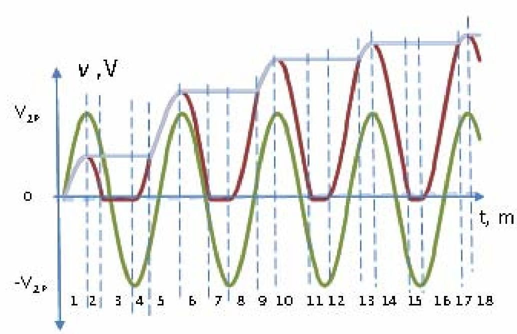
$$Vc_1 + Vc_2 = V_{2p} + \frac{V_{2p}}{2} = \frac{3V_{2p}}{2} \quad (1)$$

$$V_2 + Vc_1 = Vc_2 \quad (2)$$

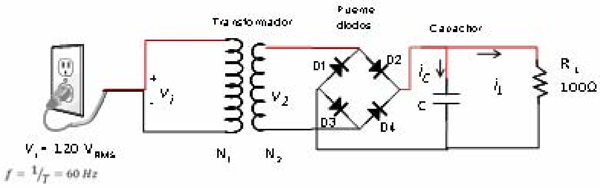
$$Vc_1 = \frac{\frac{3V_{2p}}{2} - V_2}{2}$$

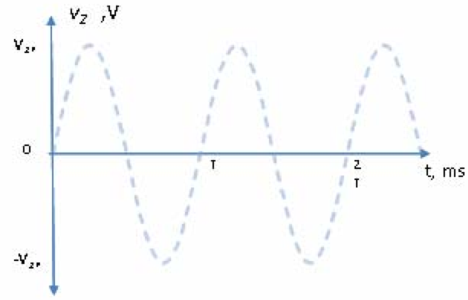
$$Vc_2 = \frac{V_2 + \frac{3V_{2p}}{2}}{2}$$

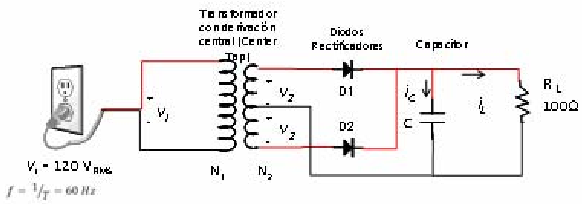
	D_1	D_2	VC_1	VD_1	VC_2
1	off	on	$-V_2/2$	$V_2/2$	$V_2/2$
2	off	off	$-V_{2p}/2$	$V_2-V_{2p}/2$	$V_{2p}/2$
3	on	off	V_2	0	$V_{2p}/2$
4	off	off	V_{2p}	V_2+V_{2p}	$V_{2p}/2$
5	off	on	$\frac{\frac{3V_{2p}}{2} - V_2}{2}$	$\frac{V_2 + \frac{3V_{2p}}{2}}{2}$	$\frac{V_2 + \frac{3V_{2p}}{2}}{2}$
6	off	off	$V_{2p}/4$	$V_2+V_{2p}/4$	$5V_{2p}/4$
7	on	off	V_2	0	$5V_{2p}/4$



Rectificador de onda completa:

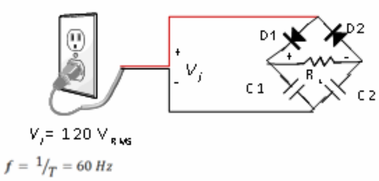






$$v_{\text{riz,p-p}} = \frac{V_{2P}\left(T/_2\right)}{\tau}$$

$$v_{\text{riz,p-p}} \approx \frac{V_{2P}}{2fR_LC}$$



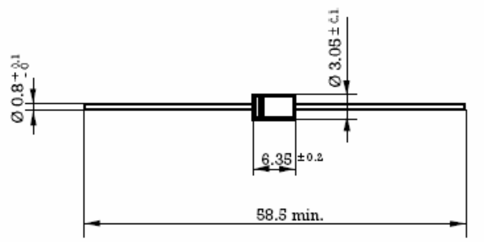
Encontrar el voltaje en R_L ($\to \infty$)

340 V

1.5 Amp. Silicon Rectifier Diodes

Dimensions in mm.

DO-15
(Plastic)



Mounting instructions

1. Min. distance from body to soldering point, 4 mm.
2. Max. solder temperature, 350°C.
3. Max. soldering time, 3,5 sec.
4. Do not bend lead at a point closer than 2 mm. to the body.

Voltage
50 to 1000 V.

Current
1.5 A. at 70°C.

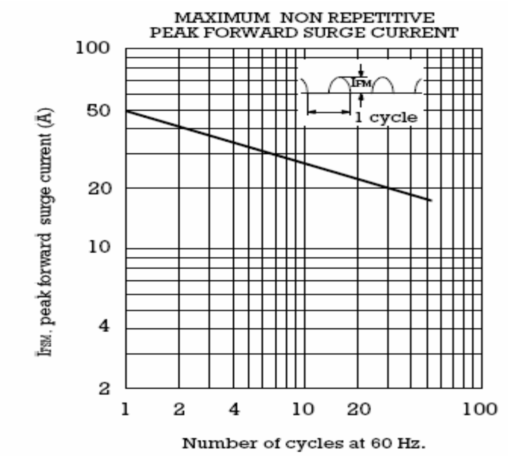
- Low cost
- Diffused junction
- High current capability
- The plastic material carries U/L recognition 94 V-0
- Terminals: Axial Leads
- Polarity: Color band denotes cathode

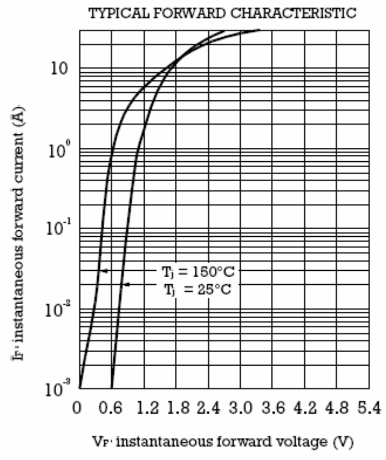
Maximum Ratings, according to IEC publication No. 134

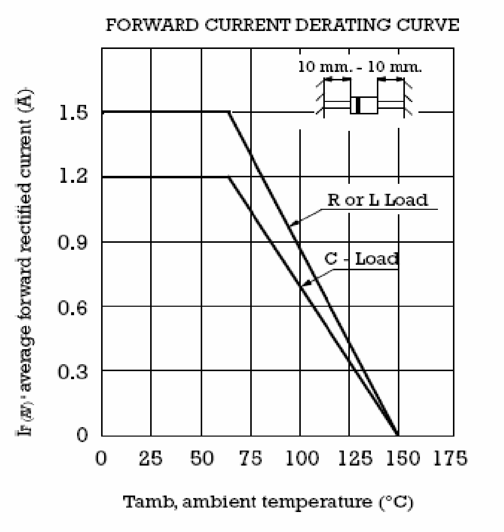
		1N 5391	1N 5392	1N 5393	1N 5394	1N 5395	1N 5396	1N 5397	1N 5398	1N 5399
V_{RRM}	Peak recurrent reverse voltage (V)	50	100	200	300	400	500	600	800	1000
$I_{F(AV)}$	Forward current at Tamb = 70°C	1.5 A								
I_{FRM}	Recurrent peak forward current	10 A								
I_{FSM}	8.3 ms. peak forward surge current (Jedec Method)	50 A								
T_j	Operating temperature range	– 65 to + 150 °C								
T_{stg}	Storage temperature range	– 65 to + 150 °C								

Electrical Characteristics at Tamb = 25°C

V_F	Max. forward voltage drop at I_F = 1.5 A		1.2 V
I_R	Max. reverse current at V_{RRM}	at 25°C at 150°C	5 μ A 300 μ A
R_{thj-a}	Max. thermal resistance (l = 10 mm.)		60° C/W


MAXIMUM NON REPETITIVE
PEAK FORWARD SURGE CURRENT
IFM
1 cycle
100
50
20
10
4
2
1
2
4
10
20
100
Number of cycles at 60 Hz.
IFSM, peak forward surge current (A)


TYPICAL FORWARD CHARACTERISTIC
10
10⁰
10⁻¹
10⁻²
10⁻³
Tj = 150°C
Tj = 25°C
0
0.6
1.2
1.8
2.4
3.0
3.6
4.2
4.8
5.4
VF, instantaneous forward voltage (V)
IF, instantaneous forward current (A)


FORWARD CURRENT DERATING CURVE
10 mm. - 10 mm.
R or L Load
C - Load
1.5
1.2
0.9
0.6
0.3
0
0
25
50
75
100
125
150
175
Tamb, ambient temperature (°C)
IF(AV), average forward rectified current (A)