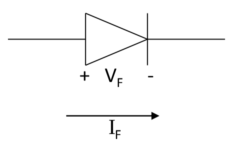
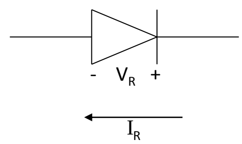
DIODO

Definición:

- Dispositivo Semiconductor
- Dos terminales
- Permite la Circulación de corriente (I) en un solo sentido

Símbolo y convenciones V - I:

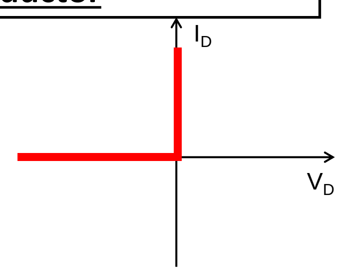


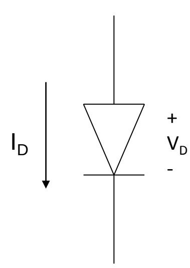


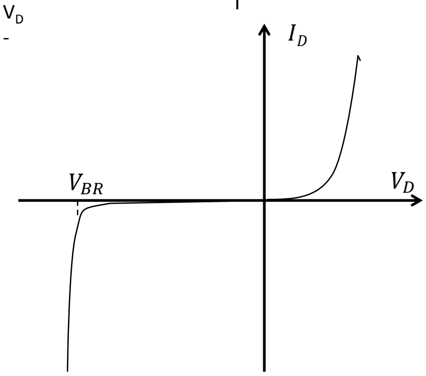
DIODO Ideal vs. Semiconductor

DIODO IDEAL

$V_D > 0 \Rightarrow I_D \rightarrow \infty$



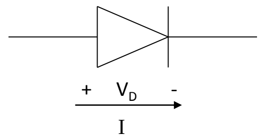




DIODO Semiconductor

$I_D = Is\ [\ \exp\ (V_D/U_T) - 1]$

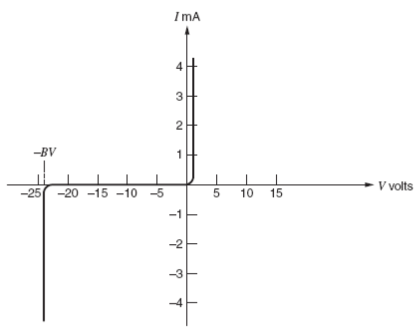
Relación V – I (Modelo Diodo Ideal)

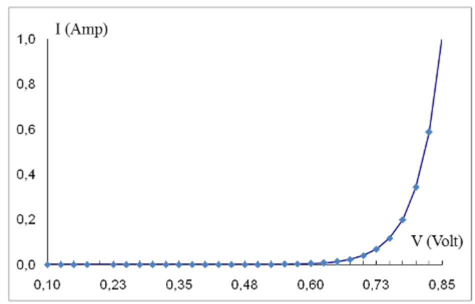


$$I = Is\,[\,\exp(V_D/U_T) - 1]$$

Is ⟶ Fabricación

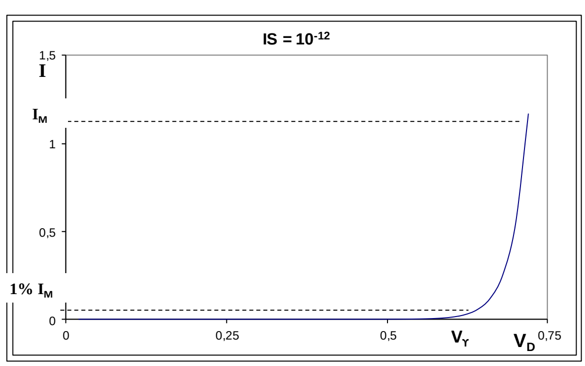
$$UT = k\,T\,/\,q$$





$$I = Is\,[\,\exp(V_D/U_T) - 1]$$

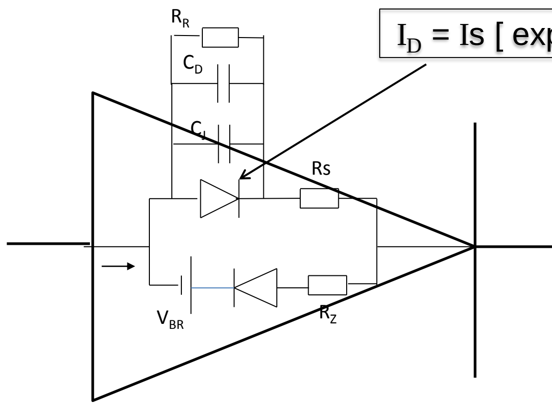
- Dos diodos se diferencian entre si a través del valor de Is
- Is refleja el proceso de fabricación (material, concentraciones, dimensiones)
- Is depende de la temperatura.
- La V_Y (Tensión umbral) se define como la tensión que produce el 1% del valor de corriente máxima que puede conducir el Diodo



Limitaciones del modelo del Diodo Semiconductor

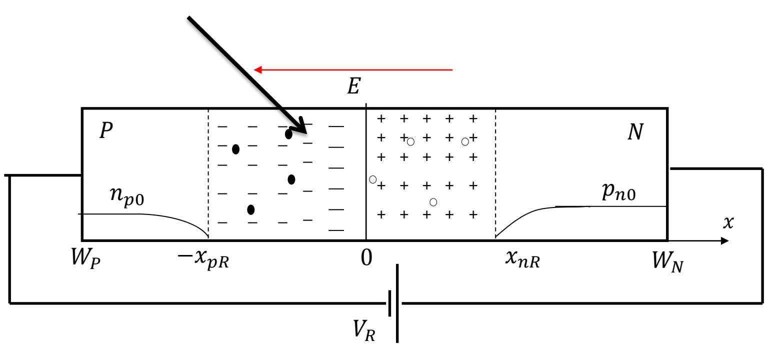
- Resistencia serie (Rs)
- Máxima Tensión Inversa (V_{BR})
- Capacidad de Juntura (C_j)
- Capacidad de difusión (C_D)
- Generación en Zona de Deplexión
- Recombinación en Zona de Deplexión
- Máxima Temperatura de Juntura (T_{jM})
- Máxima Corriente Directa (I_{FM})

$I_D = Is\ [\ \exp(V_D/U_T) - 1]$



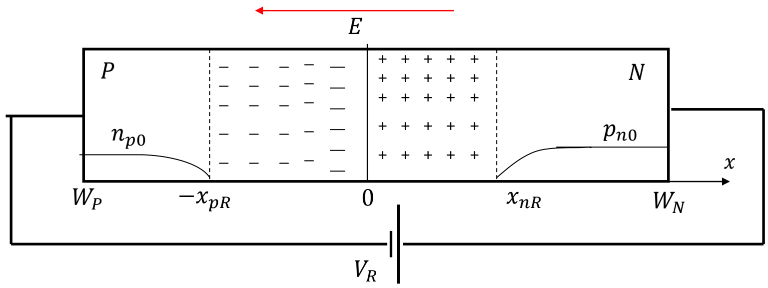
Generación en Zona de Deplexion → Corriente inversa mayor que Is

Con polarización inversa en ZD el producto **p** x **n < n_i^2** → Tendencia a la Generación

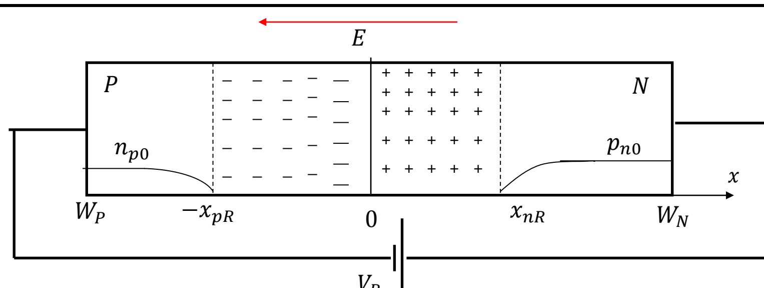


La corriente inversa medida es mayor que Is

MAXIMA TENSION INVERSA



- Los portadores minoritarios que atraviesan la Zona de deplexion son acelerados por el campo.
- Al atravesar la ZD los portadores chocan con los átomos, en estos choques, si los portadores tienen la energía cinética suficiente, pueden liberar electrones de la ligaduras covalentes de los átomos. Estos electrones son nuevos portadores
- El proceso de generación de portadores por choque en la ZD se llama "Avalancha" y se produce cuando el campo (E_{MAX}) en la ZD alcanza el valor necesario para que la energía cinética de los portadores produzca la liberación de electrones de las ligaduras covalentes



Campo eléctrico en x = 0 ⟶ $E_{MAX} = \left(\frac{2qN_AN_D}{\varepsilon(N_A+N_D)}\right)^{1/2}(V_R+V_{j0})^{1/2}$

Valor del campo eléctrico para el que comienza el proceso de "Avalancha" ⟶ $E_{Critico} = \frac{4\times 10^5}{1-\frac{1}{3}log\left(\frac{N}{10^{16}}\right)}$

Cuando → $E_{MAX} \geq E_{Critico}$ → Avalancha en la ZD

La tensión V_R que hace que $E_{MAX} = E_{Critico}$

Es V_{BR}→ Máxima tensión de bloqueo inversa

- Al aumentar la temperatura disminuye λ (camino libre medio)
- Esta disminución de λ (camino libre medio) implica una disminución de la energía cinética que adquieren los portadores antes de chocar
- Para compensar esta disminución de la energía cinética debo aumentar el campo que acelera los portadores
- Por tanto el aumento de temperatura hace necesario un campo mayor para provocar la avalancha

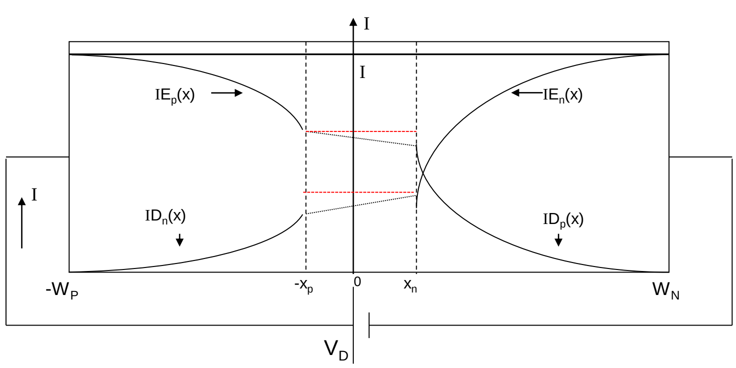
$T \uparrow \Longrightarrow V_{BR} \uparrow$ ⟶ Para AVALANCHA

- Ruptura Zener

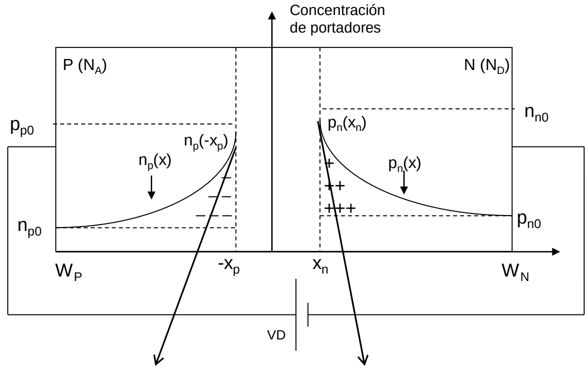
Recombinación en zona de deplexion

$$I = Is\,[\,\exp(V_D/\,\eta\,U_T) - 1]$$

$\eta \cong 2$
Para Si



Inyección de Alto Nivel



Cuando $n_p(-x_p) \cong p_{p0}$ o $p_n(x_n) \cong n_{n0}$

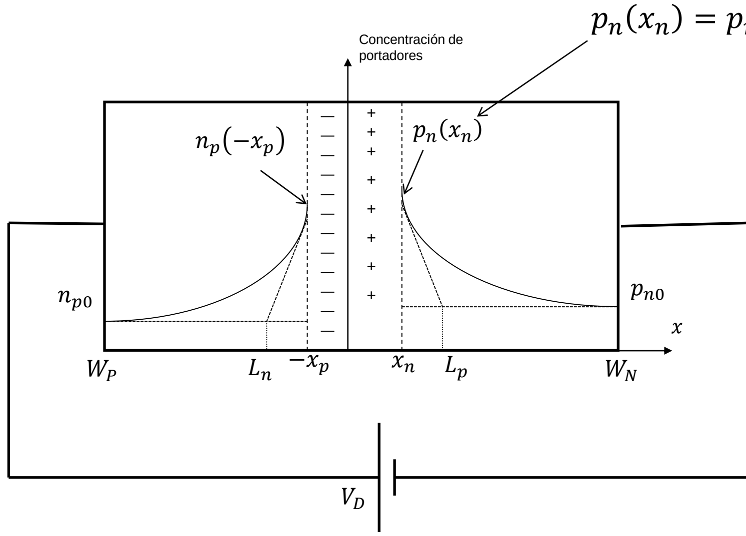
Se produce la ruptura de la neutralidad eléctrica

El campo se opone al paso de los portadores

La corriente disminuye

$$I = Is\,[\,\exp(V_D/\eta\, U_T) - 1]$$

$$p_n(x_n) = p_{n0}e^{\frac{V_D}{U_T}}$$



$$p_n(x_n) = n_{n0} = N_D$$

$$p_n(x_n) = p_{n0} e^{\frac{V_D}{U_T}} \qquad p_{n0} = \frac{n_i^2}{N_D} \qquad p_n(x_n) = \frac{n_i^2}{N_D} e^{\frac{V_D}{U_T}}$$

Condición de inyección de alto nivel

$$p_n(x_n) = n_{n0} = N_D$$

$$N_D = \frac{n_i^2}{N_D} e^{\frac{V_D}{U_T}}$$

TENSION DE POLARIZACION A LA QUE COMIENZA LA INYECCION DE ALTO NIVEL

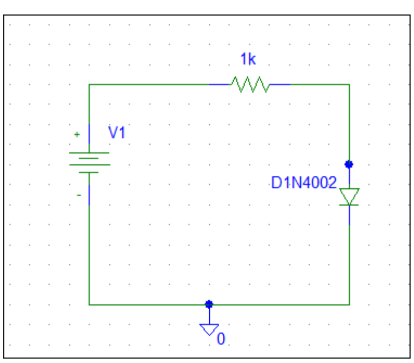
$$V_D = 2U_T \ln \frac{N_D}{n_i}$$

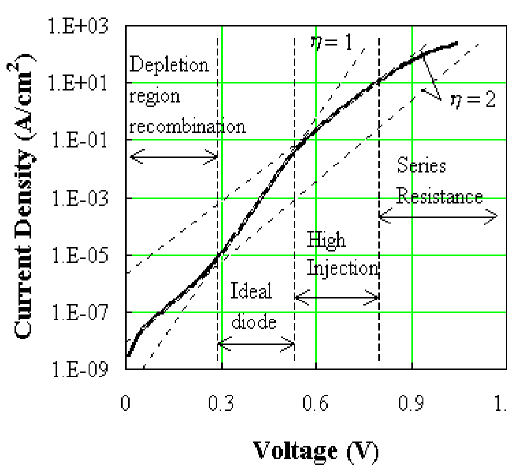
Ejemplo: Juntura N^+P con $N_A = 10^{17}$ $N_D = 10^{15}$ T = 300 °K

$$V_D = 2x0{,}026 \ln \frac{10^{15}}{10^{10}} = 0{,}598 \text{ V}$$

$I = I_s$ [exp $(V_D / \eta U_T) - 1$]

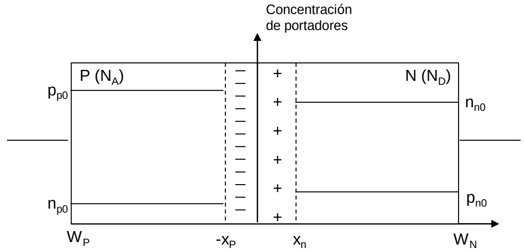
$$ln \frac{I}{I_S} = \frac{V_D}{\eta V_T}$$



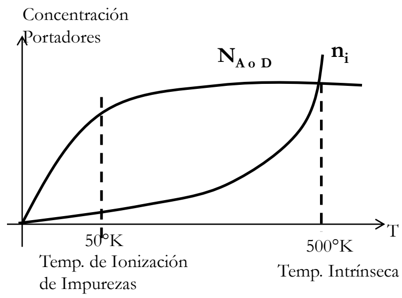


Máxima Temperatura de Juntura (T_{jM})

$p_{p0} = N_A$
$n_{p0} = n_i^2 / N_A$



$n_{n0} = N_D$
$p_{n0} = n_i^2 / N_D$



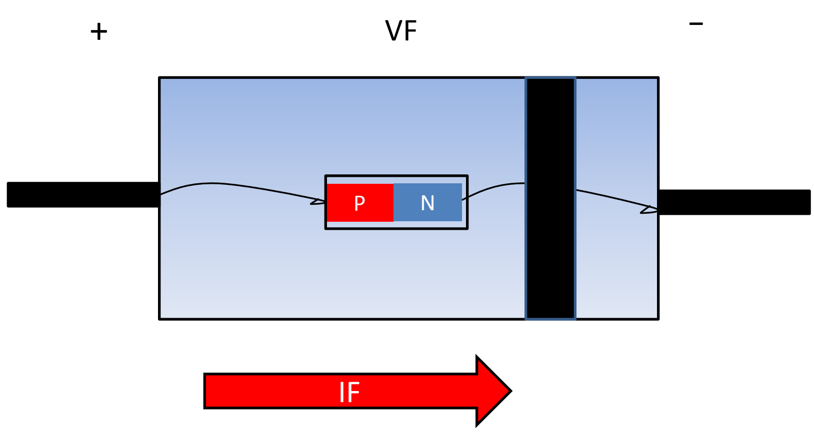
$$n_i^2 = A_\circ T^3 e^{-E_G/kT}$$

Para T = $T_{Intrinseca} \Rightarrow n_i \cong N_D$ o NA

$n_{n0} \cong p_{n0}$ o $p_{p0} \cong n_{p0}$

El semiconductor deja de ser EXTRINSECO

Máxima Corriente Directa (I_{FM})



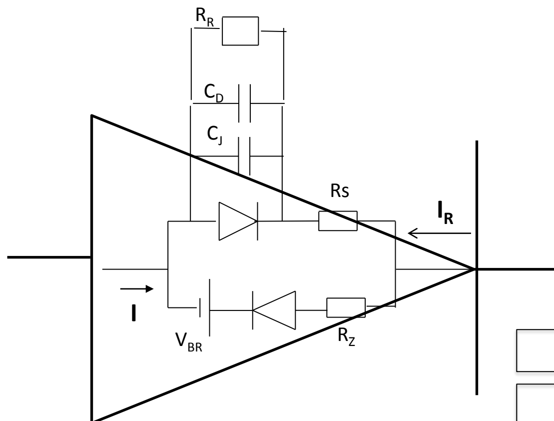
MODELO DEL DIODO

$I = I_S\,[\,\exp(V_D/\,\eta\, U_T) - 1]$

$I_R = M\, I_S$

$n \sim 3\ a\ 6$

$$M = \frac{1}{1-\left(\frac{V_R}{V_{BR}}\right)^n}$$



$$C_j = \frac{C_{j0}}{\sqrt[m]{1+\frac{V_R}{V_{j0}}}}$$

$m = 2 \rightarrow Junt.\,abrupta$

$m = 3 \rightarrow Junt.\,gradual$

$$C_D = T_T \frac{I}{U_T}$$

PARAMETROS DEL MODELO

I_S | R_S | V_{BR} | C_{j0} | T_T | η | V_{j0}

ECUACIONES DEL MODELO

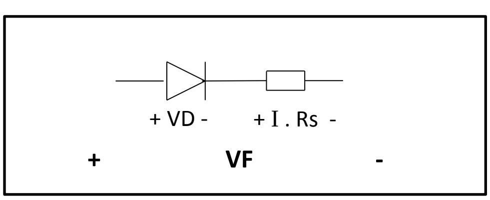
$I = Is\,[\,\exp(V_D/\,\eta\, U_T) - 1]$

$I_R = M\, I_S$

$$M = \frac{1}{1-\left(\frac{V_R}{V_{BR}}\right)^n}$$

$$C_j = \frac{C_{j0}}{\sqrt{1+\frac{V_R}{V_{J0}}}}$$

$$C_D = T_T \frac{I_D}{V_T}$$



$V_F = V_D + I\,.\,Rs$

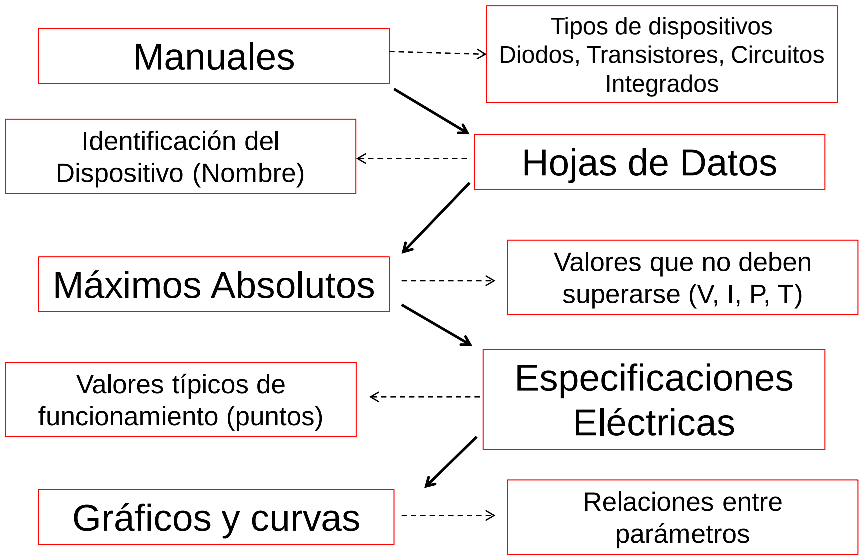
CLASIFICACION DE LOS DIODOS

- Material
  - Ge
  - Si
  - As Ga
- Potencia
  - Señal (P < 1 watt)
  - Potencia (P > 1 watt)

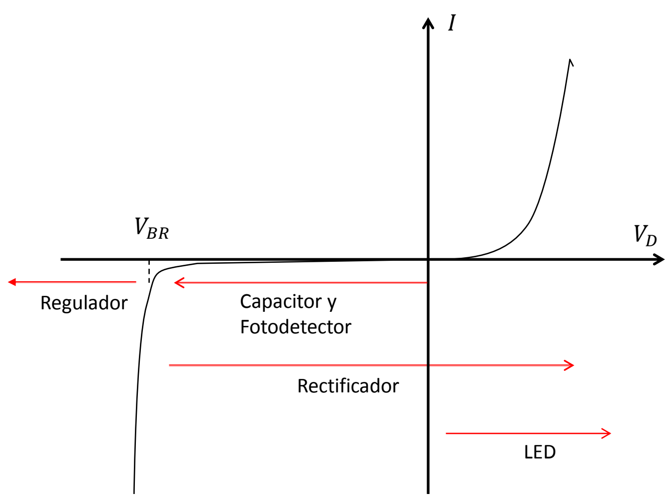
CLASIFICACION DE LOS DIODOS

- FUNCION EN LOS CIRCUITOS
  - RECTIFICADORES
    - Normales
    - Rapidos
    - Ultrarapidos
    - Schottky
  - REGULADORES (ZENER)
  - CAPACITORES (VARICAP)
  - EMISORES DE LUZ (LEDS)
  - DETECTORES DE LUZ (FOTODETECTORES)

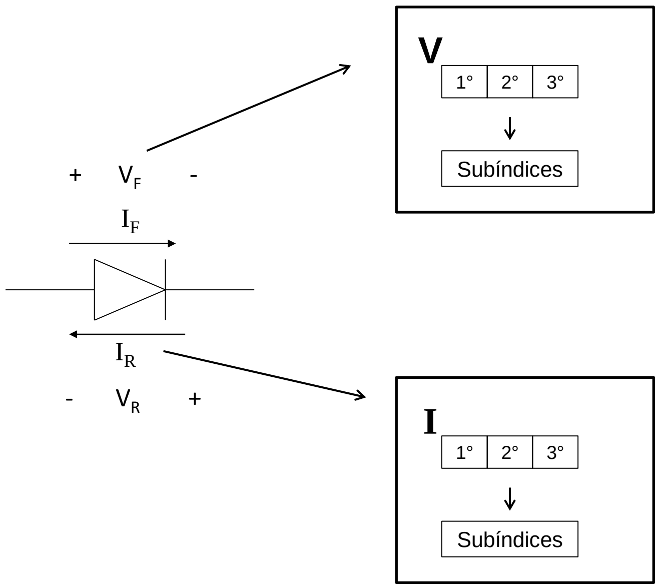
ESPECIFICACION DE DISPOSITIVOS SEMICONDUCTORES

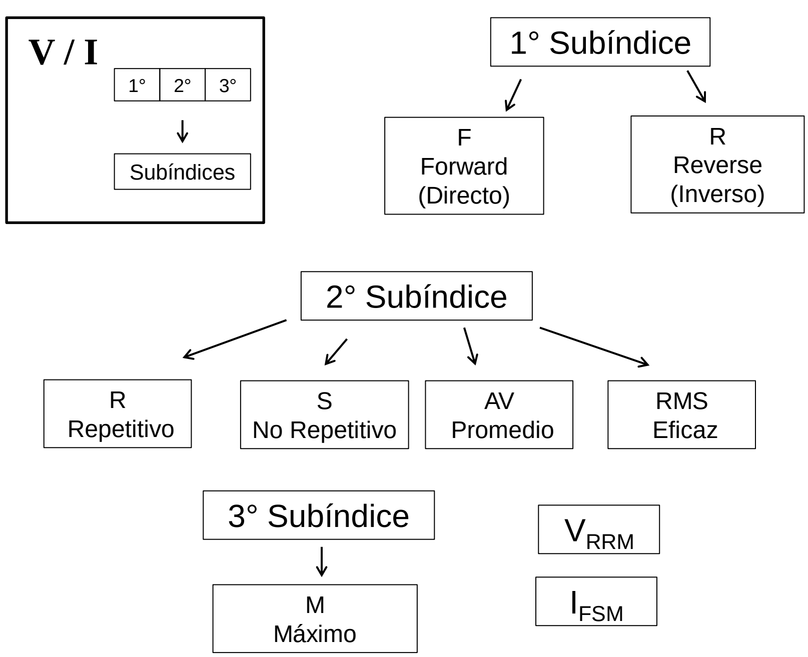


ZONA DE FUNCIONAMIENTO DE CADA TIPO DE DIODO



Convenciones de tensiones y corrientes





FAIRCHILD SEMICONDUCTOR®

1N4001 - 1N4007

Features

- Low forward voltage drop.
- High surge current capability.

DO-41
COLOR BAND DENOTES CATHODE

General Purpose Rectifiers (Glass Passivated)

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value							Units
		4001	4002	4003	4004	4005	4006	4007	
V_{RRM}	Peak Repetitive Reverse Voltage	50	100	200	400	600	800	1000	V
$I_{F(AV)}$	Average Rectified Forward Current, .375 " lead length @ T_A = 75°C	1.0							A
I_{FSM}	Non-repetitive Peak Forward Surge Current 8.3 ms Single Half-Sine-Wave	30							A
T_{stg}	Storage Temperature Range	-55 to +175							°C
T_J	Operating Junction Temperature	-55 to +175							°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

Electrical Characteristics

T_A = 25°C unless otherwise noted

Symbol	Parameter	Device							Units
		4001	4002	4003	4004	4005	4006	4007	
V_F	Forward Voltage @ 1.0 A	1.1							V
I_{rr}	Maximum Full Load Reverse Current, Full Cycle T_A = 75°C	30							μA
I_R	Reverse Current @ rated V_R T_A = 25°C T_A = 100°C	5.0 500							μA μA
C_T	Total Capacitance V_R = 4.0 V, f = 1.0 MHz	15							pF

Thermal Characteristics

Symbol	Parameter	Value	Units
P_D	Power Dissipation	3.0	W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

Typical Characteristics

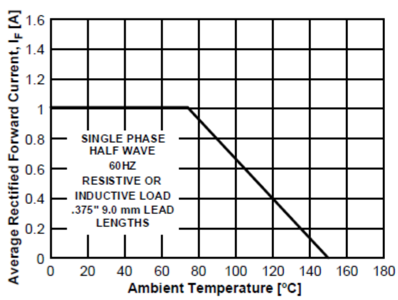


Figure 1. Forward Current Derating Curve

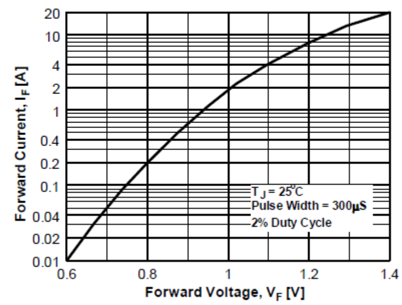


Figure 2. Forward Voltage Characteristics

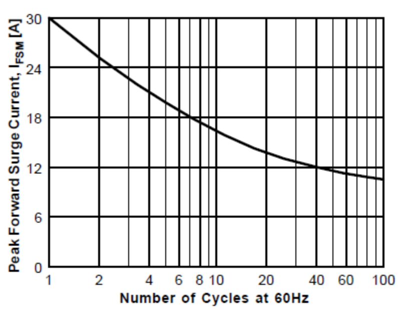


Figure 3. Non-Repetitive Surge Current

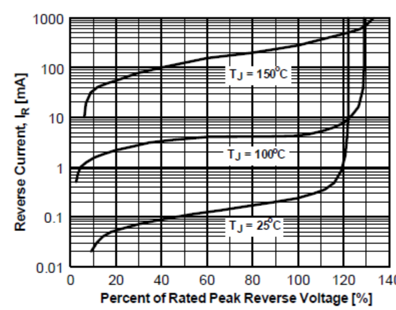


Figure 4. Reverse Current vs Reverse Voltage

VISHAY

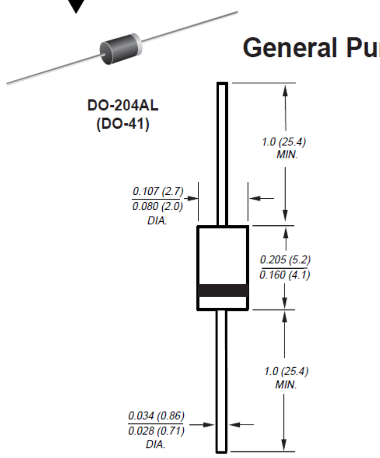
1N4001 thru 1N4007

Vishay Semiconductors
formerly General Semiconductor

General Purpose Plastic Rectifier

Reverse Voltage 50 to 1000V
Forward Current 1.0A

DO-204AL (DO-41)



NOTE: *Lead diameter is* *0.026 (0.66) / 0.023 (0.58)* *for suffix "E" part numbers*

Features

- Plastic package has Underwriters Laboratories Flammability Classification 94V-0
- Construction utilizes void-free molded plastic technique
- Low reverse leakage
- High forward surge capability
- High temperature soldering guaranteed: 350°C/10 seconds, 0.375" (9.5mm) lead length, 5 lbs. (2.3kg) tension

Mechanical Data

Case: JEDEC DO-204AL, molded plastic body
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes cathode end
Mounting Position: Any
Weight: 0.012 oz., 0.3 g

Maximum Ratings & Thermal Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

Parameter	Symb.	1N 4001	1N 4002	1N 4003	1N 4004	1N 4005	1N 4006	1N 4007	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" (9.5mm) lead length at T_A = 75°C	$I_{F(AV)}$	1.0							A
* Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) T_A = 75°C	I_{FSM}	30							A
* Maximum full load reverse current, full cycle average 0.375" (9.5mm) lead length T_L = 75°C	$I_{R(AV)}$	30							µA
Typical thermal resistance(1)	$R_{\theta JA}$ $R_{\theta JL}$	50 25							°C/W
* Maximum DC blocking voltage temperature	T_A	+150							V
* Operating junction and storage temperature range	T_J, T_{STG}	–50 to +175							°C

Electrical Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

Parameter	Symb.	Value	Unit
Maximum instantaneous forward voltage at 1.0A	V_F	1.1	V
* Maximum DC reverse current at rated DC blocking voltage, T_A = 25°C / T_A = 125°C	I_R	5.0 / 50	µA
Typical junction capacitance at 4.0V, 1MHz	C_J	15	pF

Note: (1) Thermal resistance from junction to ambient at 0.375" (9.5mm) lead length, P.C.B. mounted *JEDEC registered values

1N4001 thru 1N4007

Vishay Semiconductors
formerly General Semiconductor

VISHAY

Ratings and Characteristic Curves (T_A = 25°C unless otherwise noted)

Fig. 1 – Forward Current Derating Curve

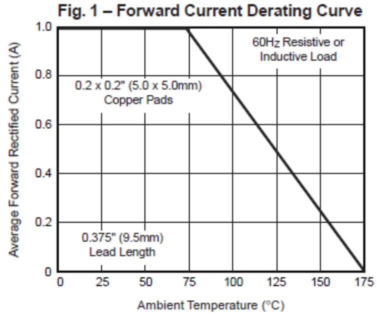


Fig. 2 – Maximum Non-Repetitive Peak Forward Surge Current

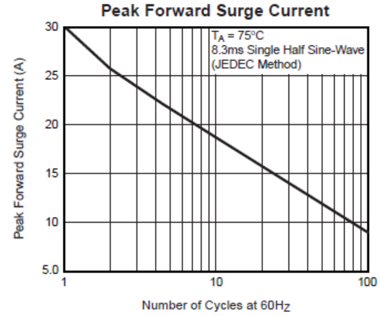


Fig. 3 – Typical Instantaneous Forward Characteristics

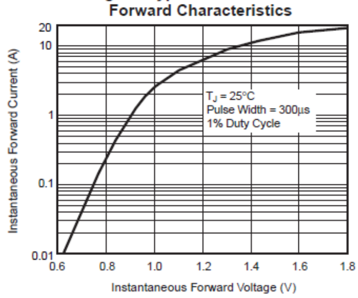


Fig. 4 – Typical Reverse Characteristics

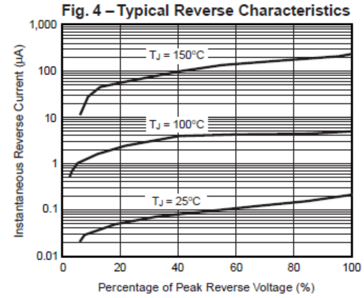


Fig. 5 – Typical Junction Capacitance

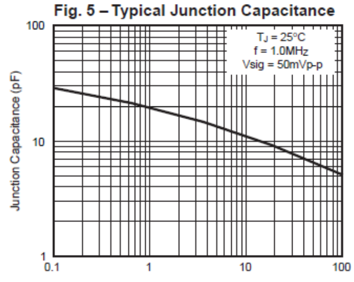
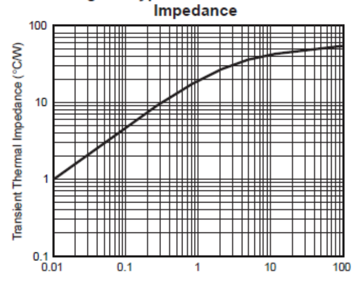
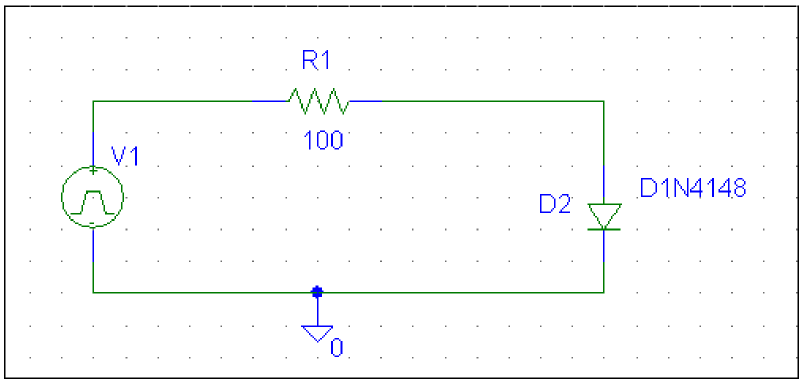
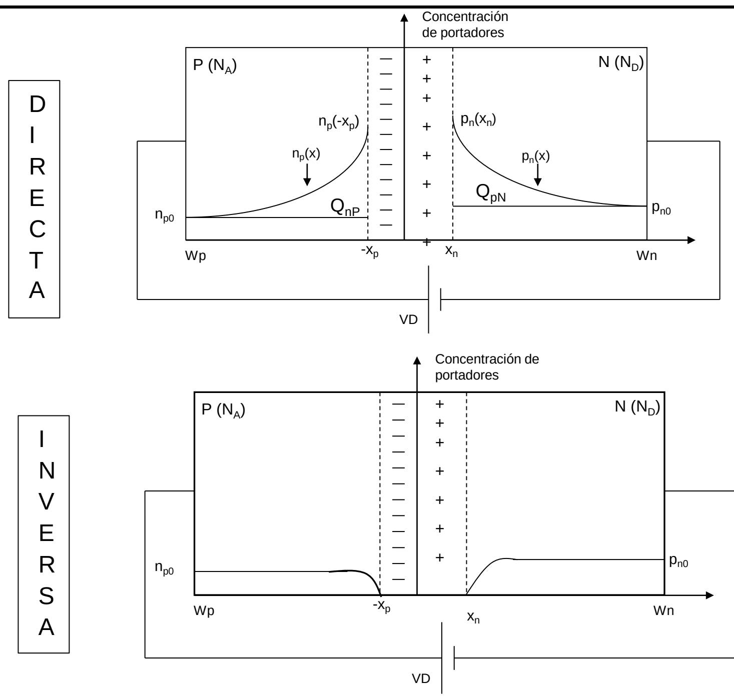


Fig. 6 – Typical Transient Thermal Impedance

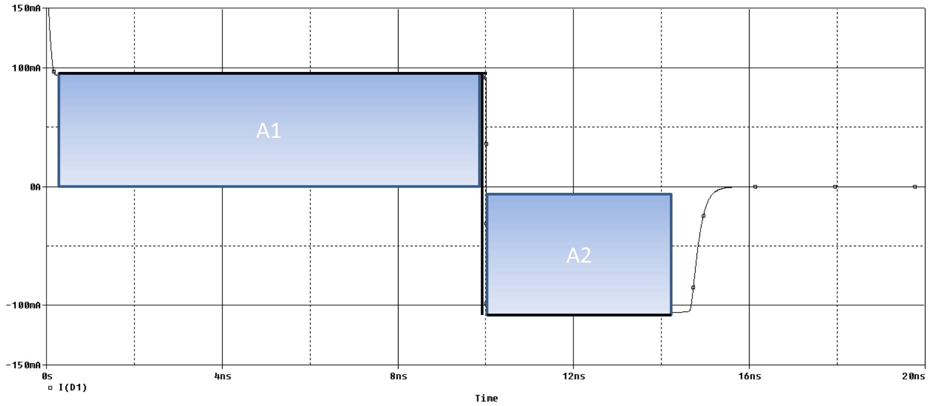


Tiempo de recuperación t_{rr}





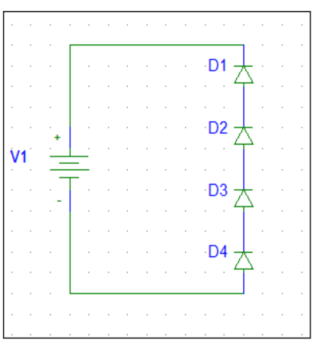
MAXIMA FRECUENCIA DE RECTIFICACION

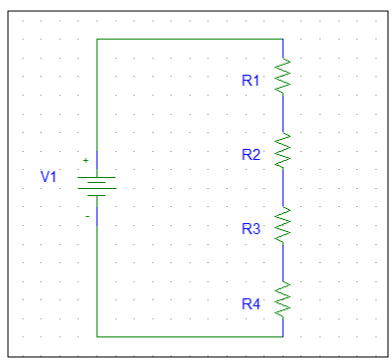


Debe ser A1 >> A2 $\frac{T}{2} \gg t_{rr}$ $\frac{T}{2} = 10t_{rr}$ $T = 20t_{rr}$ $f = \frac{1}{T}$

$$f_{max} \leq \frac{1}{20t_{rr}}$$

DIODOS SERIE



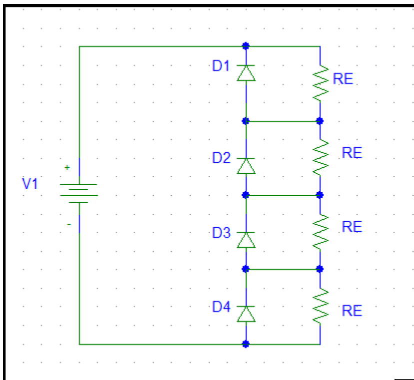


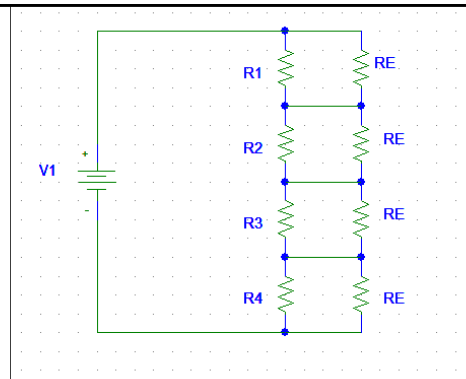
R1- R4 representan la resistencia equivalente de los diodo D1 - D4 en inversa

Si las resistencia no son iguales las tensiones en cada diodo no será igual

Ejemplo: Diodos de 1000 V de tensión inversa – Fuente 4000 V

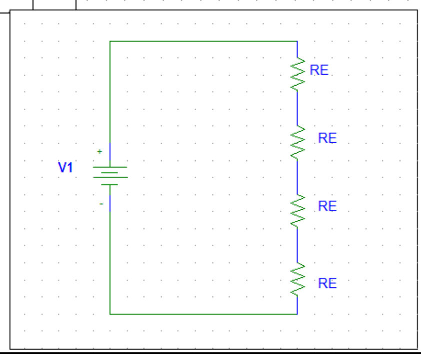
La caída en alguno de los diodos será mayor que 1000 V



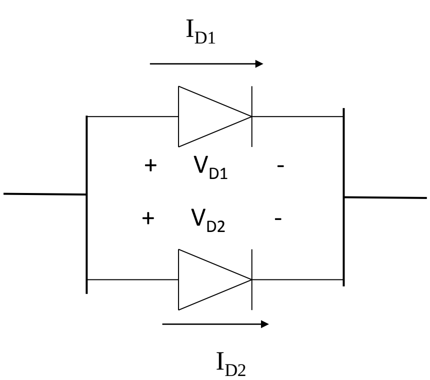


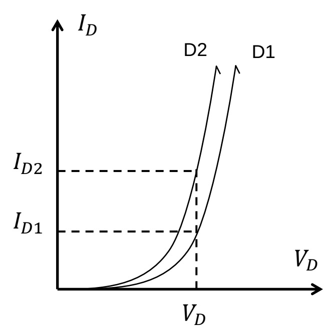
SI

RE << $(R1\text{-}R4)_{MIN}$



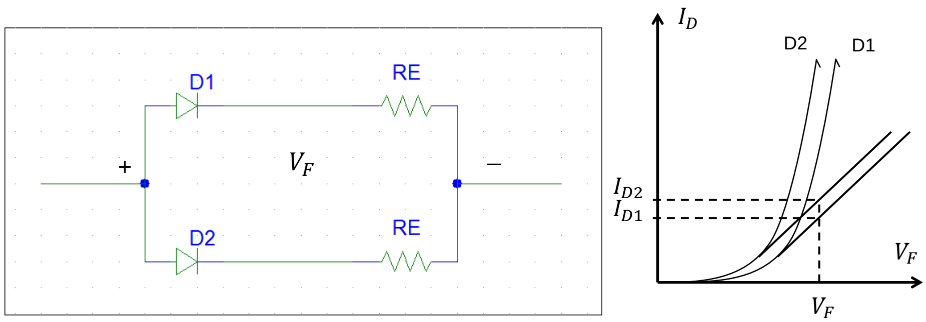
DIODOS Paralelo





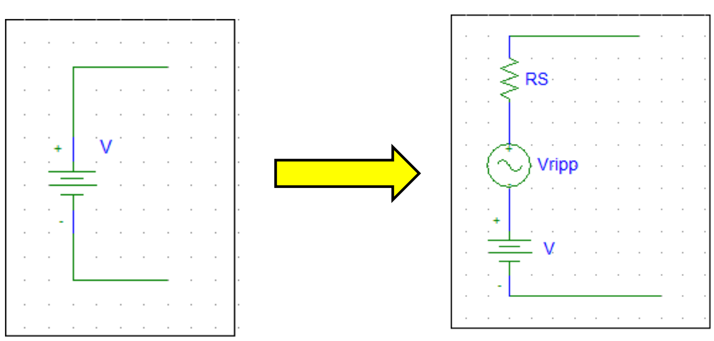
- Por la conexión VD1 = VD2
- Si las características no son idénticas uno de los diodos conducirá mas corriente

DIODOS Paralelo



RE >> $(Rd1-Rd2)_{MAX}$

REGULADOR DE TENSION



Fuente Ideal

$R_S = 0$

$V_{Ripp} = 0$

$\Delta V = 0$

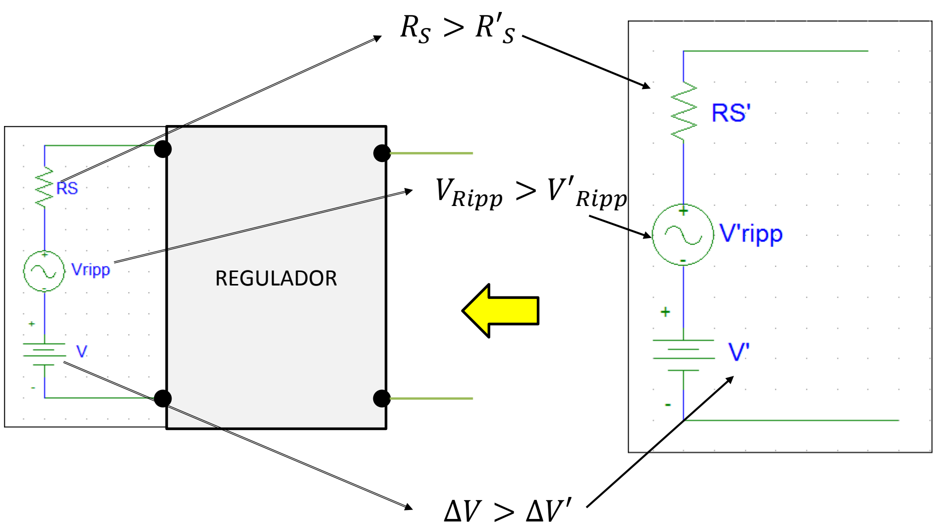
Fuente Real

$R_S \neq 0$

$V_{Ripp} \neq 0$

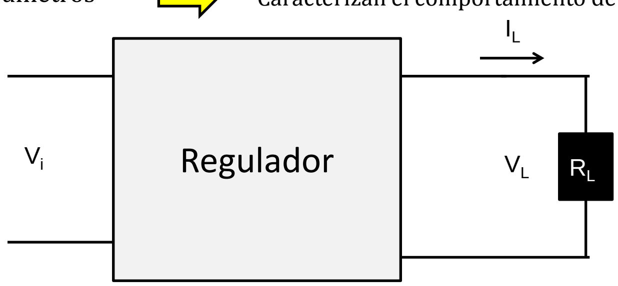
$\Delta V \neq 0$

REGULADOR DE TENSION



PARAMETROS DE LA FUENTE DE TENSION

Parámetros ⇒ Caracterizan el comportamiento de la Fuente de Tensión



Máxima corriente de salida I_{LM}

Tensión nominal de salida V_{LN}

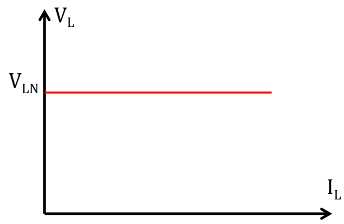
Tensión de Rippple de salida V_{LRipp}

Regulación de línea

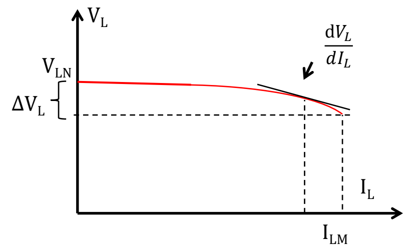
$$r_l = \frac{1}{V_{LN}} \frac{\Delta V_L}{\Delta V_i} \underset{I_L = cte.}{\longrightarrow}$$

Máxima Temperatura Ambiente de funcionamiento $T_{AMB(Max)}$

PARAMETROS DE LA FUENTE DE TENSION



Fuente Ideal



Fuente Real

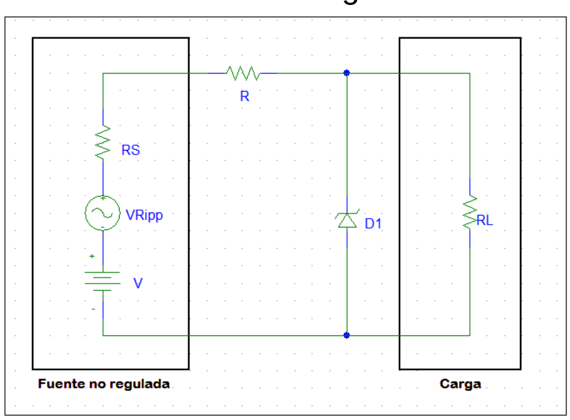
Regulación de carga

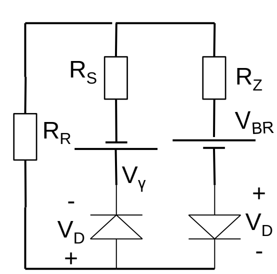
$$r_c = \frac{\Delta V_L}{V_L} \xrightarrow[\frac{\Delta I_L}{I_L}=100\%]{V_i=cte.}$$

Resistencia de salida R_0

$$R_0 = \frac{dV_L}{dI_L} \xrightarrow[I_L \sim I_{LM}]{V_i=cte.}$$

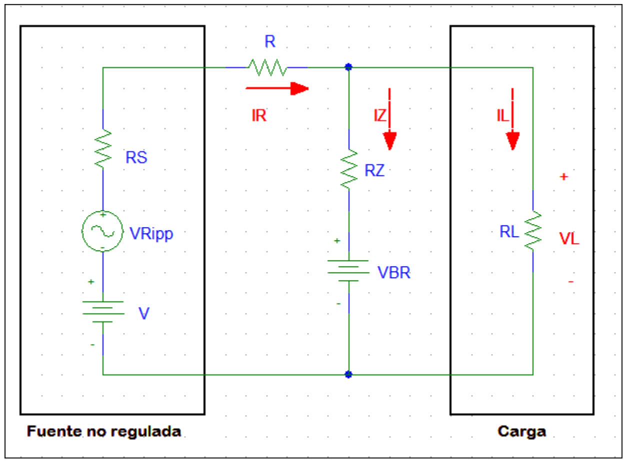
Regulador con diodo ZENER





- Entre la Fuente no regulada y la carga conectamos la resistencia R y el diodo regulador (Zener) D1
- Si la tensión sobre el diodo es mayor que su tensión de bloqueo inverso VBR podemos reemplazarlo por el modelo en conducción inversa

Regulador con diodo ZENER

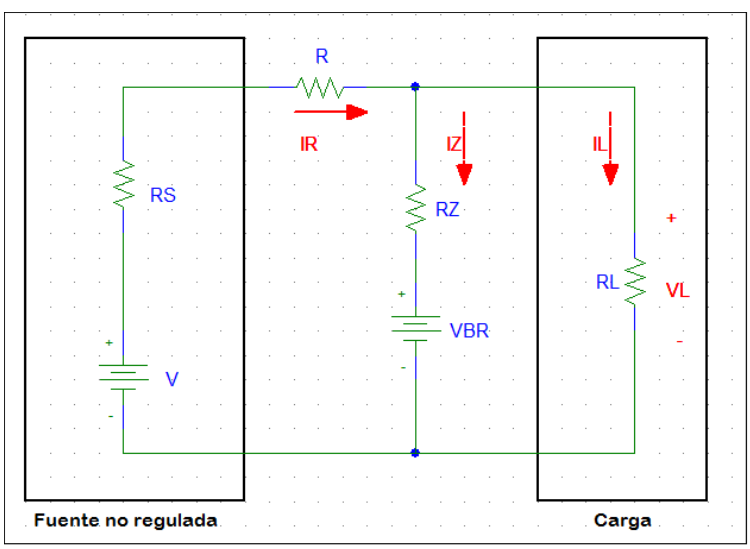


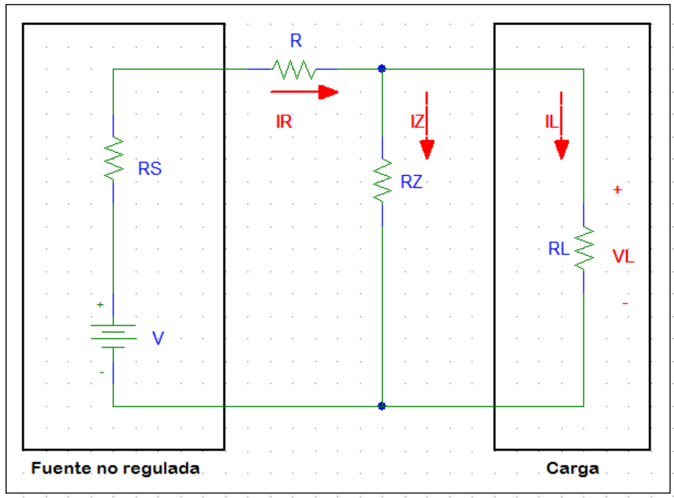
Circuito del regulador si $V>V_{BR}$

Usando el circuito calculamos

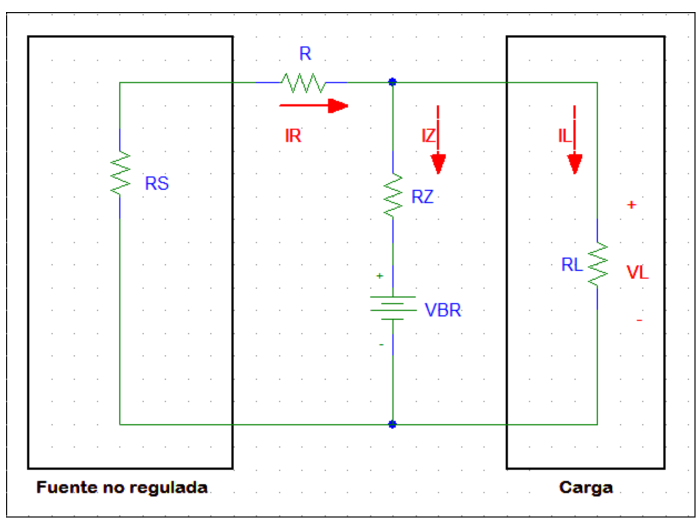
- V_L
- V_{LRipp}
- Regulación de carga
- Resistencia de salida

Circuito para calcular V_L





$$V_{L1} = V\frac{R_Z \,//\, R_L}{(R_S + R + R_Z \,//\, R_L)}$$



$$V_{L2} = V_{BR}\frac{R_L \,//\, (R + R_S)}{(R_Z + R_L \,//\, (R + R_S))}$$

$$V_L = V_{L1} + V_{L2}$$

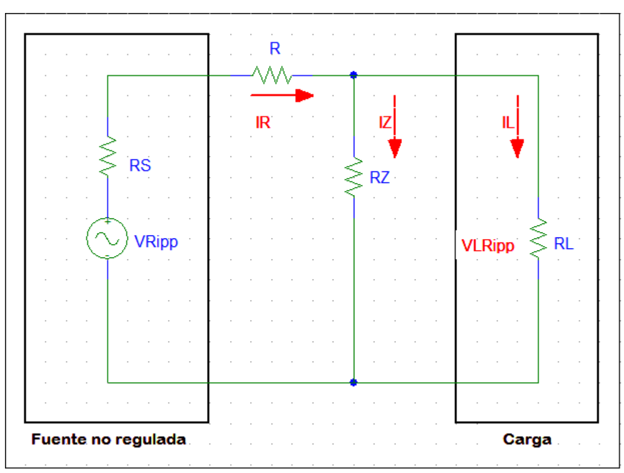
$$V_{L1} = V \frac{R_Z \,//\, R_L}{(R_S + R + R_Z \,//\, R_L)} \qquad V_{L2} = V_{BR} \frac{R_L \,//\, (R + R_S)}{(R_Z + R_L \,//\, (R + R_S))}$$

$$Si\ R \gg R_S\ y\ R_Z \qquad Si\ R_L \gg R_Z \qquad Si\ R_L \gg (R + R_S)$$

$$V_{L1} = V \frac{R_Z}{R} \qquad V_{L2} = V_{BR}$$

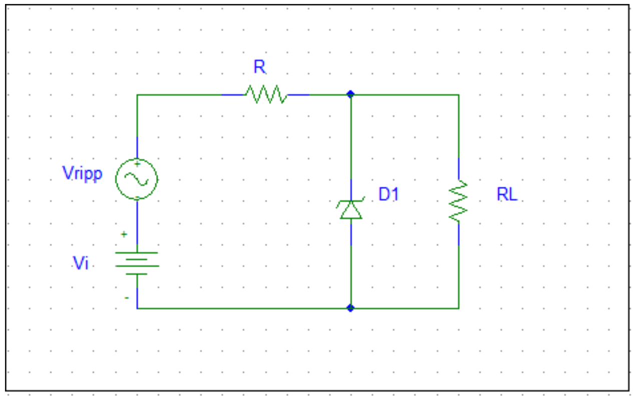
$$V_L = V_{BR} + V \frac{R_Z}{R}$$

Circuito para calcular V_{LRipp}



$$V_{LRipp} = V_{Ripp} \frac{R_Z \,//\, R_L}{(R_S + R + R_Z \,//\, R_L)} \qquad V_{LRipp} \approx V_{Ripp} \frac{R_Z}{R}$$

Regulador con diodo ZENER



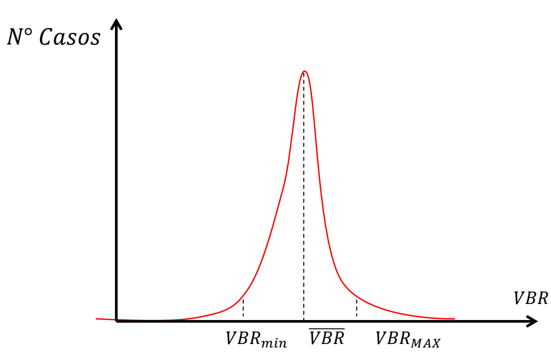
Diodos Reguladores

- Coeficiente termico
- Diferencia en las especificaciones con los rectificadores
- Hoja de datos de diodo Zener

Diodo Rectificador vs Diodo Regulador (ZENER)

- La misma fabricación

- Distintas zonas de trabajo
  - Rectificador $|V_{BR}| > V_D$
  - Regulador $|V_{BR}| < V_D$
- Distintas especificaciones en
  - Máximos Absolutos
  - Características Eléctricas



1N4728A to 1N4764A

Vishay Semiconductors

Silicon Power Zener Diodes

Features
- Silicon Planar Power Zener Diodes
- For use in stabilizing and clipping circuits with high power rating.

949369

- Standard Zener voltage tolerance suffix "A" for ± 5 % tolerance. Other Zener voltages and tolerances are available upon request.

Applications
Voltage stabilization

Mechanical Data
Case: DO-41 Glass Case
Weight: approx. 350 mg
Packaging Codes/Options:
TR / 5k per 13 " reel , 25k/box
TAP / 5k per Ammo mag. (52 mm tape), 25k/box

Absolute Maximum Ratings
T_{amb} = 25 °C, unless otherwise specified

Parameter	Test condition	Symbol	Value	Unit
Power dissipation	$T_{amb} \le 50$ °C	P_{Diss}	1	W
Z-current		I_Z	P_V/V_Z	mA
Junction temperature		T_j	200	°C
Storage temperature range		T_{stg}	- 65 to + 200	°C
Junction ambient	l = 9.5 mm (3/8 "), T_L = constant	R_{thJA}	100	K/W

1N4728A to 1N4764A

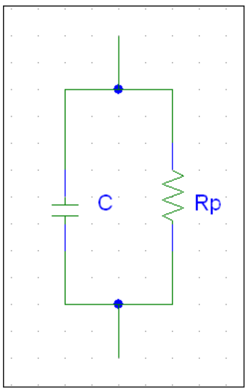
Vishay Semiconductors

Electrical Characteristics
1N4728A...1N4764A

Partnumber	Nominal Zener Voltage[1]	Test Current	Maximum Dynamic Impedance			Maximum Reverse Leakage Current		Surge curent	Maximum Regulator Current[2]
	V_Z @ I_{ZT}	I_{ZT}	Z_{ZT} @ I_{ZT}	Z_{ZK} @ I_{ZK}	I_{ZK}	I_R	Test Voltage V_R	I_R @ T_{amb} = 25 °C	I_{ZM} @ T_{amb} = 50 °C
	V	mA	Ω	Ω	mA	µA	V	mA	mA
1N4728A	3.3	76	10	400	1	100	1	1380	276
1N4729A	3.6	69	10	400	1	100	1	1260	252
1N4730A	3.9	64	9	400	1	50	1	1190	234
1N4731A	4.3	58	9	400	1	10	1	1070	217
1N4732A	4.7	53	8	500	1	10	1	970	193
1N4733A	5.1	49	7	550	1	10	1	890	178
1N4734A	5.6	45	5	600	1	10	2	810	162
1N4735A	6.2	41	2	700	1	10	3	730	146
1N4736A	6.8	37	0.5	700	1	10	4	660	133
1N4737A	7.5	34	0	700	0.5	10	5	605	121
1N4738A	8.2	31	0.5	700	0.5	10	6	550	110
1N4739A *	9.1	28	0	700	0.5	10	7	500	100
1N4740A *	10	25	7	700	0.25	10	7.6	454	91
1N4741A *	11	23	8	700	0.25	5	8.4	414	83
1N4742A *	12	21	9	700	0.25	5	9.1	380	76
1N4743A *	13	19	10	100	0.25	5	9.9	344	69
1N4744A *	15	17	14	700	0.25	5	11.4	304	61
1N4745A *	16	15.5	16	700	0.25	5	12.2	285	57
1N4746A *	18	14	20	750	0.25	5	13.7	250	50
1N4747A *	20	12.5	22	750	0.25	5	15.2	225	45
1N4748A *	22	11.5	23	750	0.25	5	16.7	205	41
1N4749A *	24	10.5	25	750	0.25	5	18.2	190	38
1N4750A *	27	9.5	35	750	0.25	5	20.6	170	34
1N4751A *	30	8.5	40	1000	0.25	5	22.8	150	30

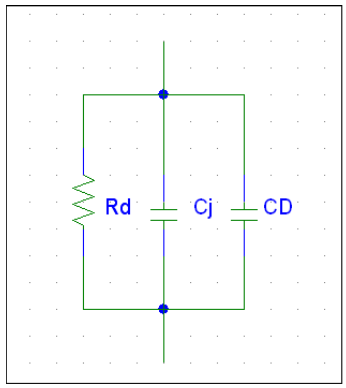
Diodo Varicap

Factor de Calidad (Q) de un capacitor



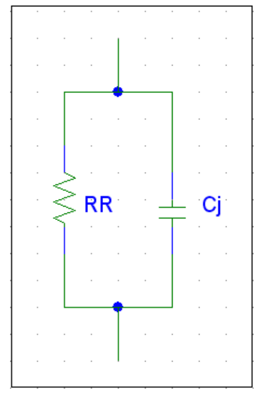
$Q = \omega C R_p$

Diodo en directo



$Rd = U_T / I_D \approx 30\ m\Omega$

Diodo en inverso

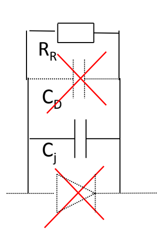


$RR \approx 100\ M\Omega$

Capacidad de Juntura (Cj) vs Capacidad de Difusión (CD)

$C_j \sim pF\ (10^{-12})$

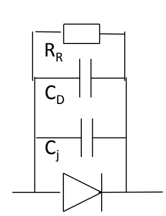
C_j esta presente siempre en polarización directa e inversa



Q (Factor de calidad)= $\omega C_j R_R$

$C_D \sim \mu F\ (10^{-6})$

C_D solo esta presente en polarización directa

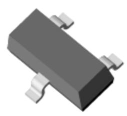


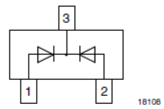
Q (Factor de calidad)= $\omega C_D (R_R \| r_d)$

BB814-V-GH

Vishay Semiconductors

Dual Varicap Diode





FEATURES

- Silicon epitaxial planar diode
- Common cathode
- AEC-Q101 qualified
- Compliant to RoHS directive 2002/95/EC and in accordance to WEEE 2002/96/EC
- Find out more about Vishay's Automotive Grade Product requirements at: www.vishay.com/applications

APPLICATIONS

- Tuning of separate resonant circuits
- Push-pull circuits in FM range
- Especially for car radios

MECHANICAL DATA

Case: SOT-23

Weight: approx. 8.1 mg

Packaging codes/options:
08/3 k per 7" reel (8 mm tape), 15 k/box

PARTS TABLE

PART	TYPE DIFFERENTIATION	ORDERING CODE	TYPE MARKING	REMARKS
BB814-1-V-GH	V_{RRM} = 20 V, C_{D2} = 43 pF to 45.5 pF	BB814-1-V-GH-08	SG1	Tape and reel
BB814-2-V-GH	V_{RRM} = 20 V, C_{D2} = 44.5 pF to 46.5 pF	BB814-2-V-GH-08	SG2	Tape and reel

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITIONS	SYMBOL	VALUE	UNIT
Repetitive peak reverse voltage		V_{RRM}	20	V
Reverse voltage		V_R	18	V
Forward current		I_F	50	mA

THERMAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITIONS	SYMBOL	VALUE	UNIT
Junction temperature		T_j	125	°C
Storage temperature range		T_{stg}	- 55 to + 150	°C

ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

PARAMETER	TEST CONDITIONS	PART	SYMBOL	MIN.	TYP.	MAX.	UNIT
Reverse current	V_R = 16 V		I_R			20	nA
	V_R = 16 V, T_j = 60 °C		I_R			200	nA
Diode capacitance (1)	V_R = 2 V	BB814-1-V-GH	C_{D2}	43		45.5	pF
		BB814-2-V-GH	C_{D2}	44.5		46.5	pF
	V_R = 8 V	BB814-1-V-GH	C_{D8}	19.1		21.95	pF
		BB814-2-V-GH	C_{D8}	19.75		22.70	pF
Capacitance ratio	V_R = 2 V, 8 V, f = 1 MHz		C_{D2}/C_{D8}	2.05		2.25	
Series resistance	C_D = 38 pF, f = 100 MHz		R_s			0.5	Ω

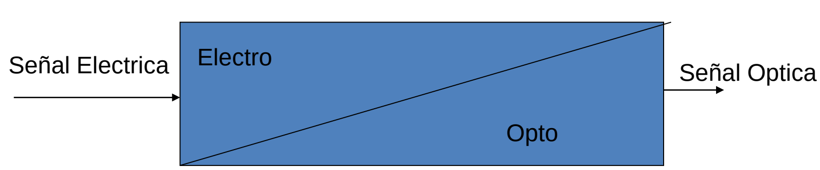
Note

(1) In the reverse voltage range of V_R = (2 V to 8 V) for diodes 4 taped in sequence the max. deviation is 3 %

DIODOS EMISORES DE LUZ (LED'S)

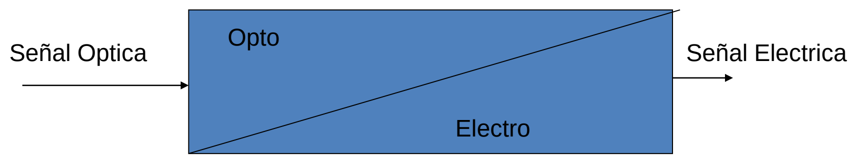
OPTOELECTRONICA

- Conversión electro optica

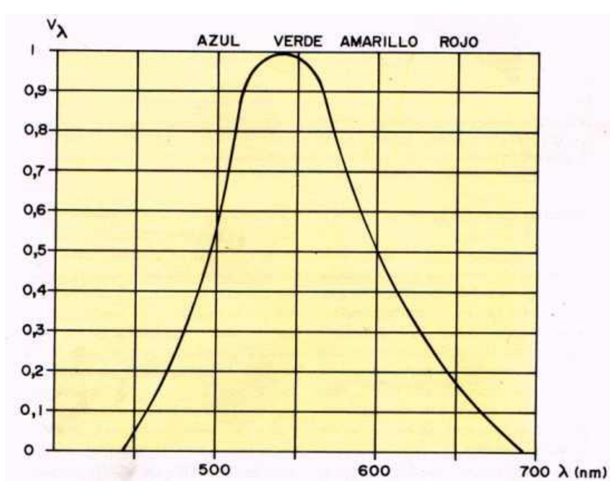


OPTOELECTRONICA

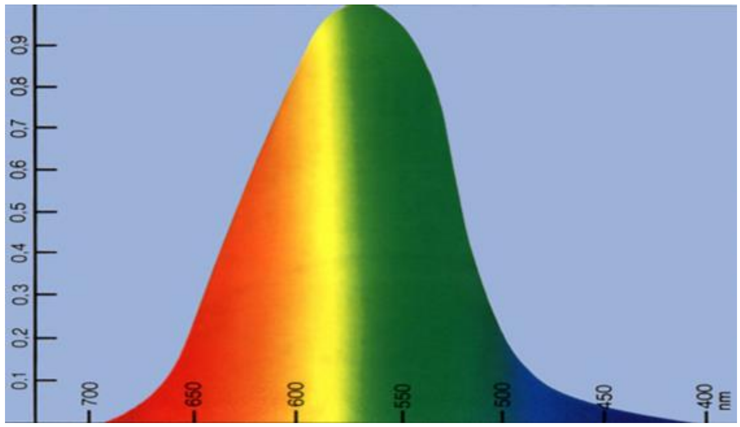
- Conversión optica electrica



Sensibilidad del ojo humano



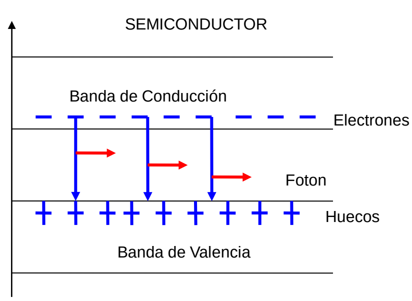
Sensibilidad del ojo humano



GENERACION DE FOTONES

•Fenómeno de recombinación de electrones de la banda de Conducción con huecos de la banda de Valencia
• Si el semiconductor es del tipo Directo se genera un Fotón desapareciendo el electrón y el hueco

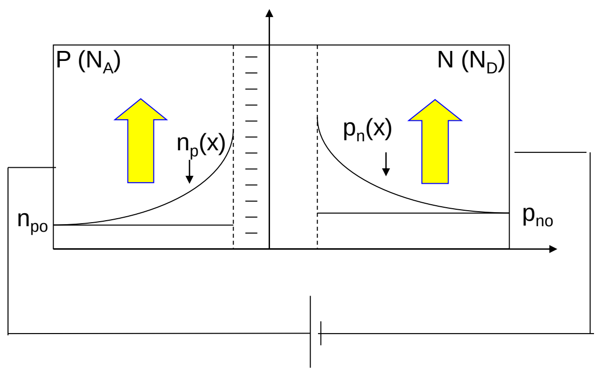
- **•El ARSENIURO DE GALIO GaAs es del tipo Directo**
- **•El Silicio Si es del tipo Indirecto, la recombinación de electrones de la banda de conducción con huecos de la banda de Valencia genera Fonones (Calor)**



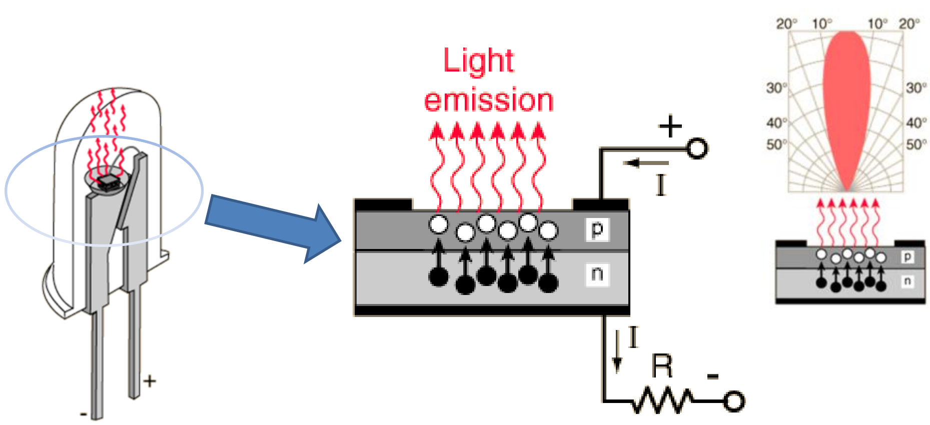
LED Light Emiting Diode

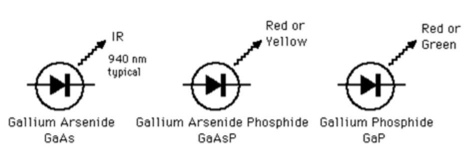
Conversión Electro - Optica

- **Juntura PN polarizada directa para favorecer el fenómeno de recombinación en zonas neutras**

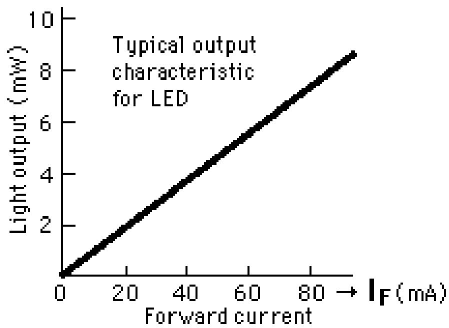


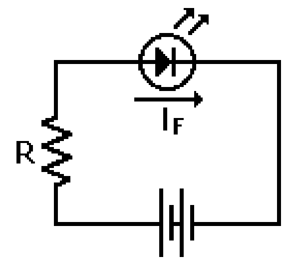
ESTRUCTURA DEL DIODO LED

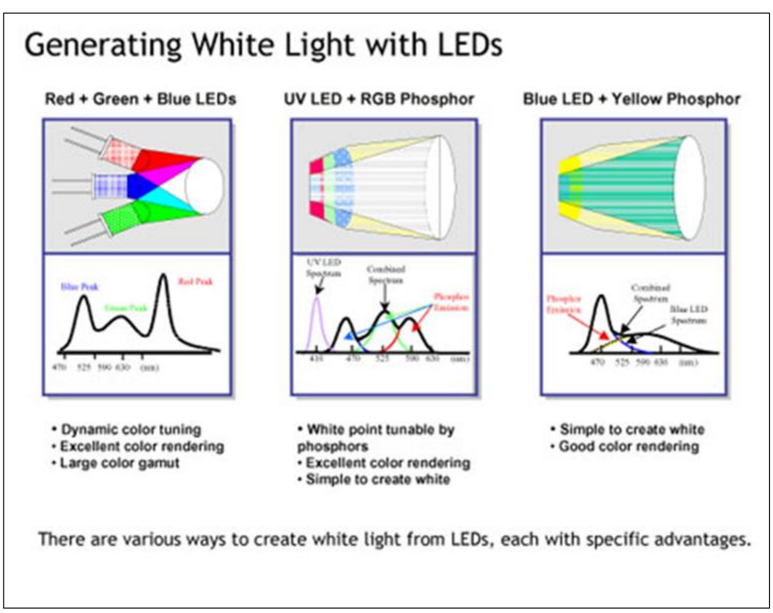




EMISION DE LUZ vs IF





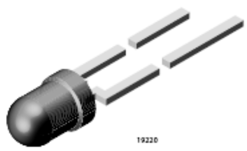


VISHAY

TLHG420., TLHO420., TLHR420., TLHY420.

Vishay Semiconductors

High Efficiency LED, Ø 3 mm Tinted Undiffused Package



FEATURES

- Choice of five bright colors
- Standard T-1 package
- Small mechanical tolerances
- Suitable for DC and high peak current
- Wide viewing angle
- Luminous intensity categorized
- Yellow and green color categorized
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/E

e8 RoHS COMPLIANT GREEN

DESCRIPTION

The TLH.42.. series was developed for standard applications like general indicating and lighting purposes.

It is housed in a 3 mm tinted clear plastic package. The wide viewing angle of these devices provides a high on-off contrast.

Several selection types with different luminous intensities are offered. All LEDs are categorized in luminous intensity groups. The green and yellow LEDs are categorized additionally in wavelength groups.

That allows users to assemble LEDs with uniform appearance.

APPLICATIONS

- Status lights
- Off/On indicator
- Background illumination
- Readout lights
- Maintenance lights
- Legend light

PRODUCT GROUP AND PACKAGE DATA

- Product group: LED
- Package: 3 mm
- Product series: standard
- Angle of half intensity: ± 22°

PARTS TABLE

PART	COLOR, LUMINOUS INTENSITY	TECHNOLOGY
TLHR4200	Red, I_V > 4 mcd	GaAsP on GaP
TLHR4201	Red, I_V > 6.3 mcd	GaAsP on GaP
TLHR4201-AS12Z	Red, I_V > 6.3 mcd	GaAsP on GaP
TLHR4205	Red, I_V > 10 mcd	GaAsP on GaP
TLHR4205-AS12	Red, I_V > 10 mcd	GaAsP on GaP
TLHR4205-AS12Z	Red, I_V > 10 mcd	GaAsP on GaP
TLHO4200	Soft orange, I_V > 4 mcd	GaAsP on GaP
TLHO4200-AS12Z	Soft orange, I_V > 4 mcd	GaAsP on GaP
TLHO4201	Soft orange, I_V > 10 mcd	GaAsP on GaP
TLHY4200	Yellow, I_V > 4 mcd	GaAsP on GaP
TLHY4200-AS12Z	Yellow, I_V > 4 mcd	GaAsP on GaP
TLHY4201	Yellow, I_V > 6.3 mcd	GaAsP on GaP
TLHY4201-AS21	Yellow, I_V > 6.3 mcd	GaAsP on GaP
TLHY4201-MS12Z	Yellow, I_V > 6.3 mcd	GaAsP on GaP
TLHY4205	Yellow, I_V > 10 mcd	GaAsP on GaP
TLHY4205-BT12Z	Yellow, I_V > 10 mcd	GaAsP on GaP
TLHY4205-LS21	Yellow, I_V > 10 mcd	GaAsP on GaP
TLHY4205-LS21Z	Yellow, I_V > 10 mcd	GaAsP on GaP
TLHY4205-MS12	Yellow, I_V > 10 mcd	GaAsP on GaP
TLHG4200	Green, I_V > 6.3 mcd	GaP on GaP
TLHG4200-AS12	Green, I_V > 6.3 mcd	GaP on GaP
TLHG4200-AS12Z	Green, I_V > 6.3 mcd	GaP on GaP
TLHG4200-AS21	Green, I_V > 6.3 mcd	GaP on GaP

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °C unless otherwise specified)
TLHG420., TLHO420., TLHR420., TLHY420.

PARAMETER	TEST CONDITION	SYMBOL	VALUE	UNIT
Reverse voltage [1]		V_R	6	V
DC forward current		I_F	30	mA
Surge forward current	$t_p \le 10\ \mu s$	I_{FSM}	1	A
Power dissipation		P_V	100	mW
Junction temperature		T_j	100	°C
Operating temperature range		T_{amb}	- 40 to + 100	°C
Storage temperature range		T_{stg}	- 55 to + 100	°C
Soldering temperature	t ≤ 5 s, 2 mm from body	T_{sd}	260	°C
Thermal resistance junction/ ambient		R_{thJA}	400	K/W

Note:
[1] Driving the LED in reverse direction is suitable for a short term application

OPTICAL AND ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °C unless otherwise specified)
TLHR420., RED

PARAMETER	TEST CONDITION	PART	SYMBOL	MIN.	TYP.	MAX.	UNIT
Luminous intensity	I_F = 10 mA	TLHR4200	I_V	4	8		mcd
		TLHR4201	I_V	6.3	10		mcd
		TLHR4205	I_V	10	15		mcd
Dominant wavelength	I_F = 10 mA		λ_d	612		625	nm
Peak wavelength	I_F = 10 mA		λ_p		635		nm
Angle of half intensity	I_F = 10 mA		φ		± 22		deg
Forward voltage	I_F = 20 mA		V_F		2	3	V
Reverse current	V_R = 6 V		I_R			10	μA
Junction capacitance	V_R = 0, f = 1 MHz		C_j		50		pF

TLHG420., TLHO420., TLHR420., TLHY420.
Vishay Semiconductors

TYPICAL CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

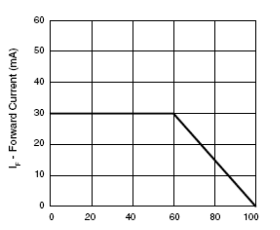


Figure 1. Forward Current vs. Ambient Temperature

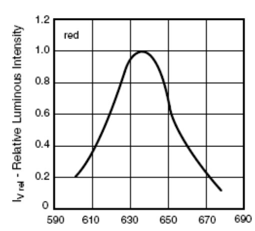


Figure 4. Relative Intensity vs. Wavelength

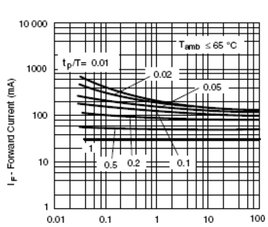


Figure 2. Forward Current vs. Pulse Length

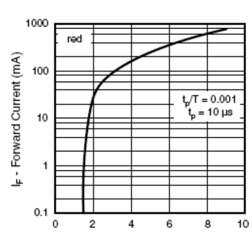


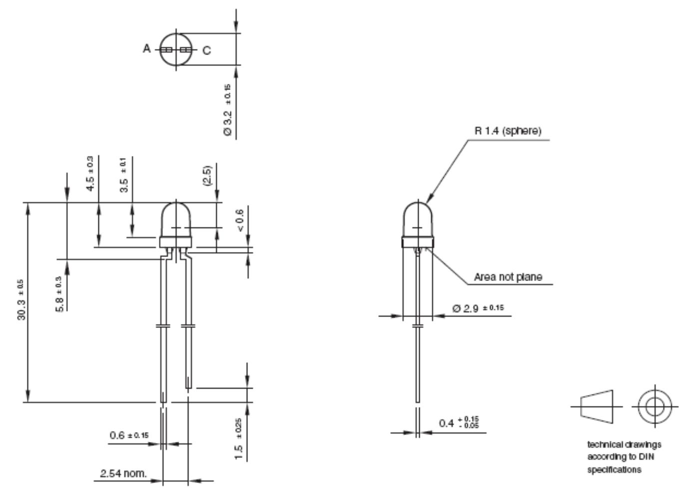
Figure 5. Forward Current vs. Forward Voltage

VISHAY

TLHG420., TLHO420., TLHR420., TLHY420.

Vishay Semiconductors

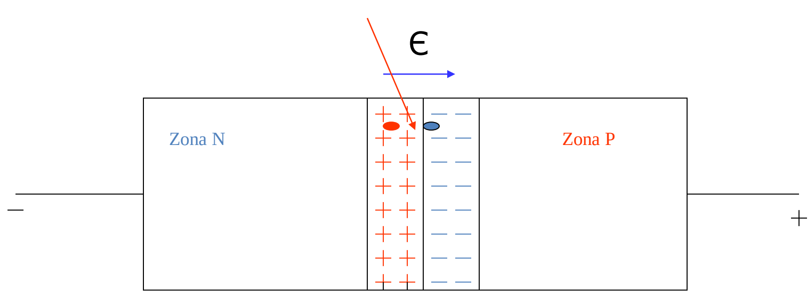
PACKAGE DIMENSIONS in millimeters



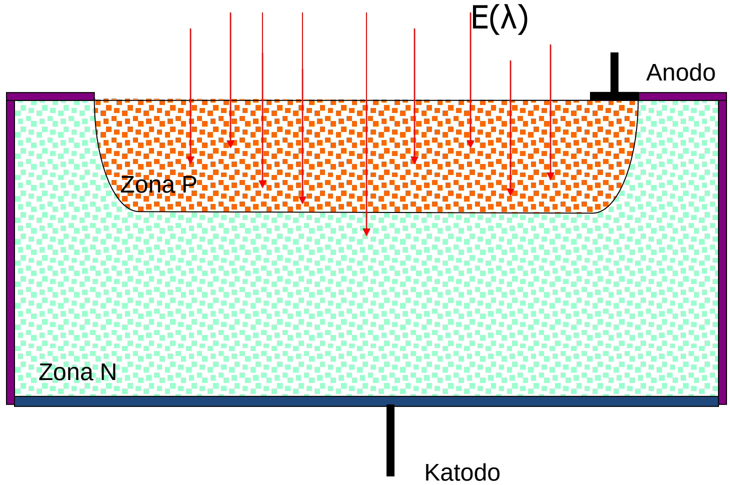
EFECTO FOTOELECTRICO DE JUNTURA

Conversión
Óptica -Electro

- **Juntura PN polarizada inversa para favorecer el fenómeno de generación en zona de deplexion**



FOTODIODO



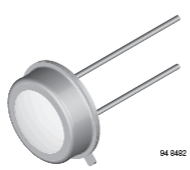
VISHAY.

www.vishay.com

BPW20RF

Vishay Semiconductors

Silicon Photodiode, RoHS Compliant



DESCRIPTION

BPW20RF is a planar Silicon PN photodiode in a hermetically sealed short TO-5 case, especially designed for high precision linear applications.

Due to its extremely high dark resistance, the short circuit photocurrent is linear over seven decades of illumination level.

On the other hand, there is a strictly logarithmic correlation between open circuit voltage and illumination over the same range.

Equipped with a clear, flat glass window, the spectral responsitivity reaches from blue to near infrared.

FEATURES

- Package type: leaded
- Package form: TO-5
- Dimensions (in mm): Ø 8.13
- Radiant sensitive area (in mm²): 7.5
- High photo sensitivity
- High radiant sensitivity
- Suitable for visible and near infrared radiation
- Angle of half sensitivity: φ = ± 50°
- Hermetically sealed package
- Cathode connected to package
- Flat glass window
- UV enhanced
- Low dark current
- High shunt resistance
- High linearity
- Compliant to RoHS Directive 2002/95/EC and in accordance with WEEE 2002/96/EC

Pb Pb-free

e4

RoHS COMPLIANT

APPLICATIONS

- Sensor for light measuring techniques in cameras, photometers, color analyzers, exposure meters (e.g. solariums) and other medical and industrial measuring and control applications.

PRODUCT SUMMARY			
COMPONENT	I_{ra} (μA)	φ (deg)	$\lambda_{0.1}$ (nm)
BPW20RF	60	± 50	400 to 1100

Note
- Test condition see table "Basic Characteristics"

ORDERING INFORMATION			
ORDERING CODE	PACKAGING	REMARKS	PACKAGE FORM
BPW20RF	Bulk	MOQ: 500 pcs, 500 pcs/bulk	TO-5

Note
- MOQ: minimum order quantity

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °C, unless otherwise specified)				
PARAMETER	TEST CONDITION	SYMBOL	VALUE	UNIT
Reverse voltage		V_R	10	V
Power dissipation	$T_{amb} \leq 50$ °C	P_V	300	mW
Junction temperature		T_j	125	°C
Operating temperature range		T_{amb}	- 40 to + 125	°C
Storage temperature range		T_{stg}	- 40 to + 125	°C
Soldering temperature	$t \leq 5$ s	T_{sd}	260	°C
Thermal resistance junction/ambient	Connected with Cu wire, 0.14 mm^2	R_{thJA}	250	K/W

BASIC CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Forward voltage	I_F = 50 mA	V_F		1.0	1.3	V
Breakdown voltage	I_R = 20 μA, E = 0	$V_{(BR)}$	10			V
Reverse dark current	V_R = 5 V, E = 0	I_{ro}		2	30	nA
Diode capacitance	V_R = 0 V, f = 1 MHz, E = 0	C_D		1.2		nF
	V_R = 5 V, f = 1 MHz, E = 0	C_D		400		pF
Dark resistance	V_R = 10 mV	R_D		38		GΩ
Open circuit voltage	E_A = 1 klx	V_o	330	500		mV
Temperature coefficient of V_o	E_A = 1 klx	TK_{Vo}		- 2		mV/K
Short circuit current	E_A = 1 klx	I_k	20	60		μA
Temperature coefficient of I_k	E_A = 1 klx	TK_{Ik}		0.1		%/K
Reverse light current	E_A = 1 klx, V_R = 5 V	I_{ra}	20	60		μA
	E_e = 1 mW/cm^2, λ = 950 nm, V_R = 5 V	I_{ra}		42		μA
Angle of half sensitivity		φ		± 50		deg
Wavelength of peak sensitivity		λ_p		920		nm
Range of spectral bandwidth		$\lambda_{0.1}$	400		1100	nm
Rise time	V_R = 0 V, R_L = 1 kΩ, λ = 820 nm	t_r		3.4		μs
Fall time	V_R = 0 V, R_L = 1 kΩ, λ = 820 nm	t_f		3.7		μs

BASIC CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

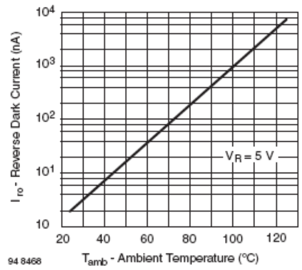


Fig. 1 - Reverse Dark Current vs. Ambient Temperature

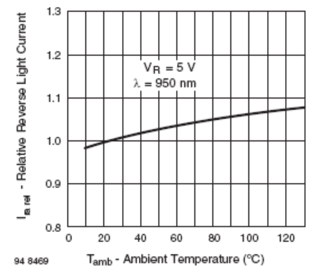


Fig. 2 - Relative Reverse Light Current vs. Ambient Temperature

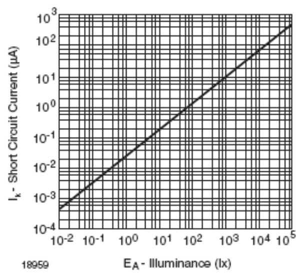


Fig. 3 - Short Circuit Current vs. Illuminance

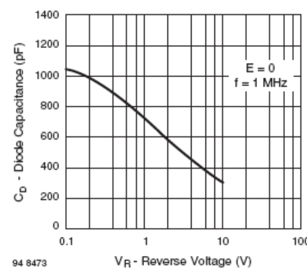


Fig. 6 - Diode Capacitance vs. Reverse Voltage

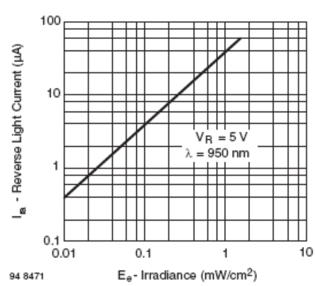


Fig. 4 - Reverse Light Current vs. Irradiance

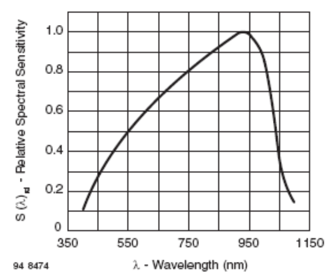


Fig. 7 - Relative Spectral Sensitivity vs. Wavelength

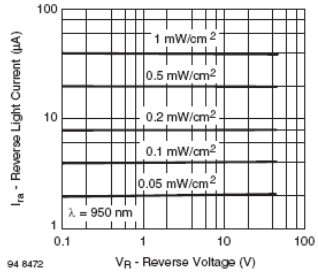


Fig. 5 - Reverse Light Current vs. Reverse Voltage

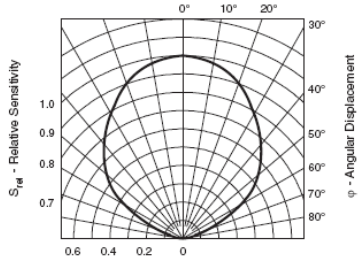


Fig. 8 - Relative Radiant Sensitivity vs. Angular Displacement

PACKAGE DIMENSIONS in millimeters