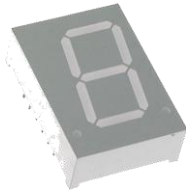
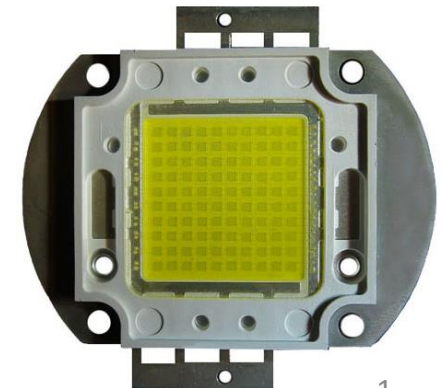
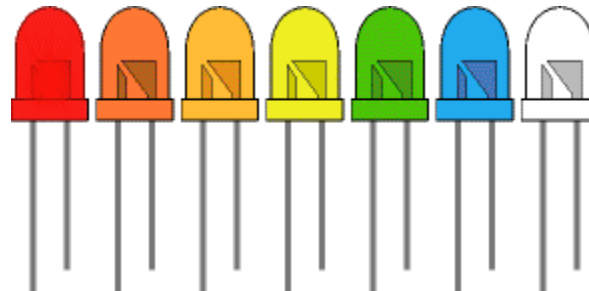


# ELECTRONICA GENERAL



**LED**

*Diodo Emisor de Luz*

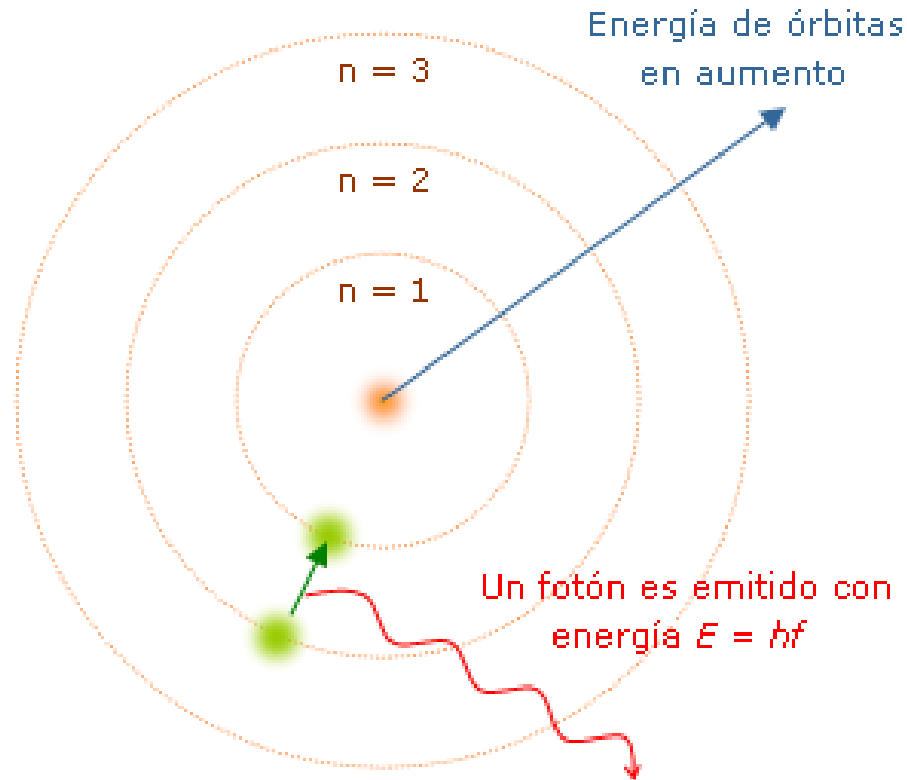


**Mgtr. Ing. Victor Hugo Kurtz**

# LED

- El término **LED**, acrónimo inglés de (***Light Emitting Diode***) Diodo Emisor de Luz.
- Basan su funcionamiento, en la propiedad de algunos materiales semiconductores, de emitir luz cuando son atravesados por una corriente eléctrica.
- El LED es un diodo que produce luz visible, invisible (infrarroja, ultravioleta) cuando se encuentra polarizado en directa. >

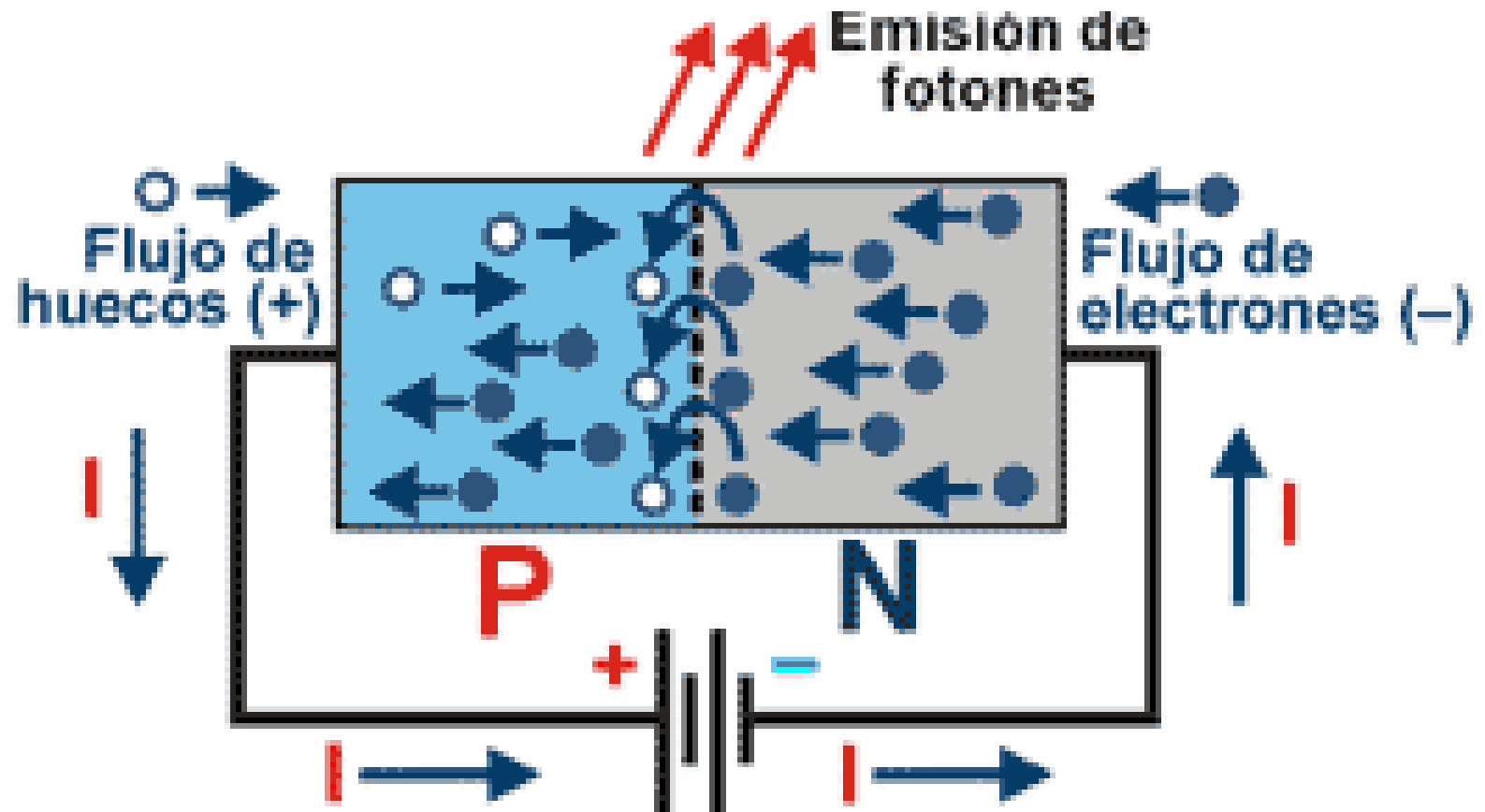
# Modelo Atómico de Bohr



Referencia:

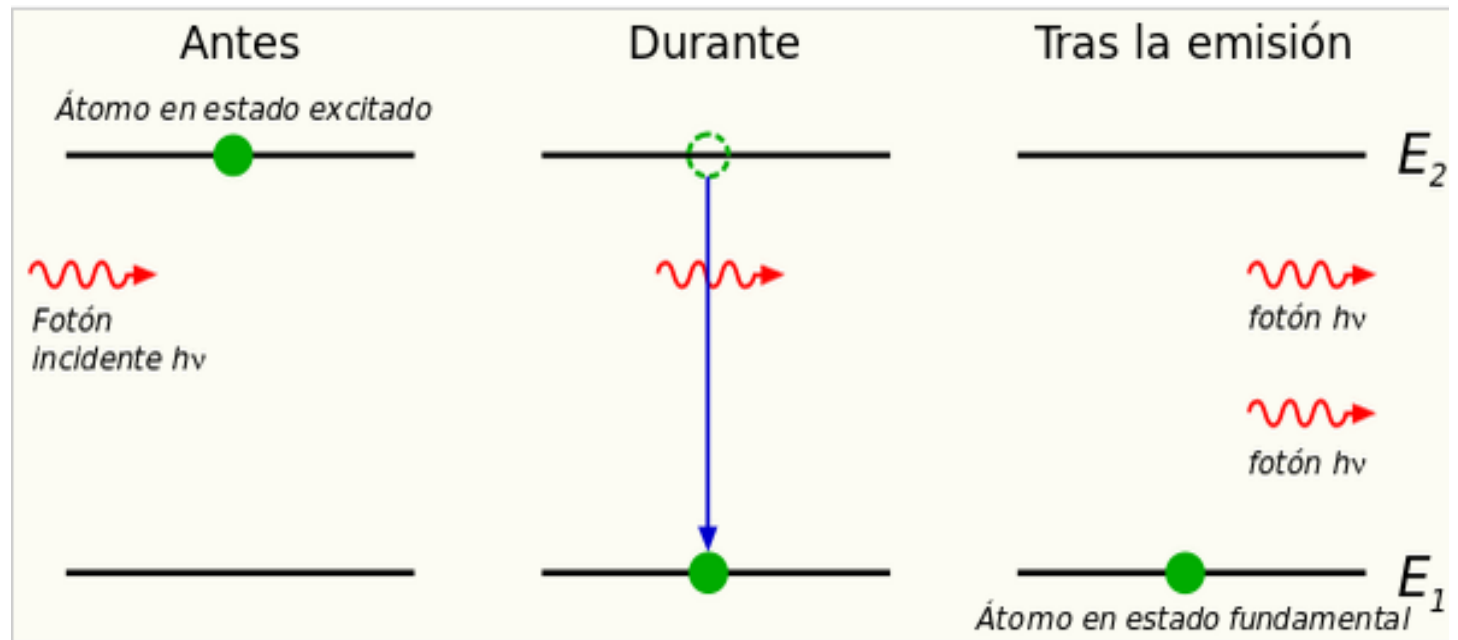
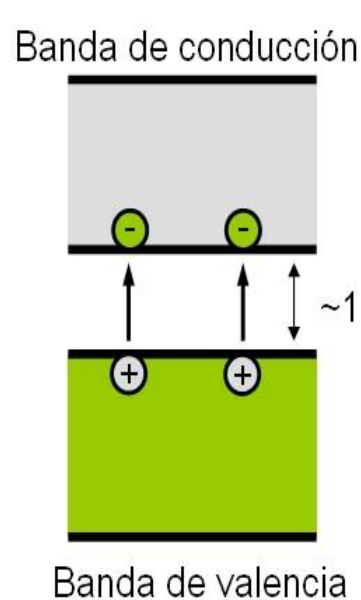
CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=202476>

# LED: Conexión en Directa

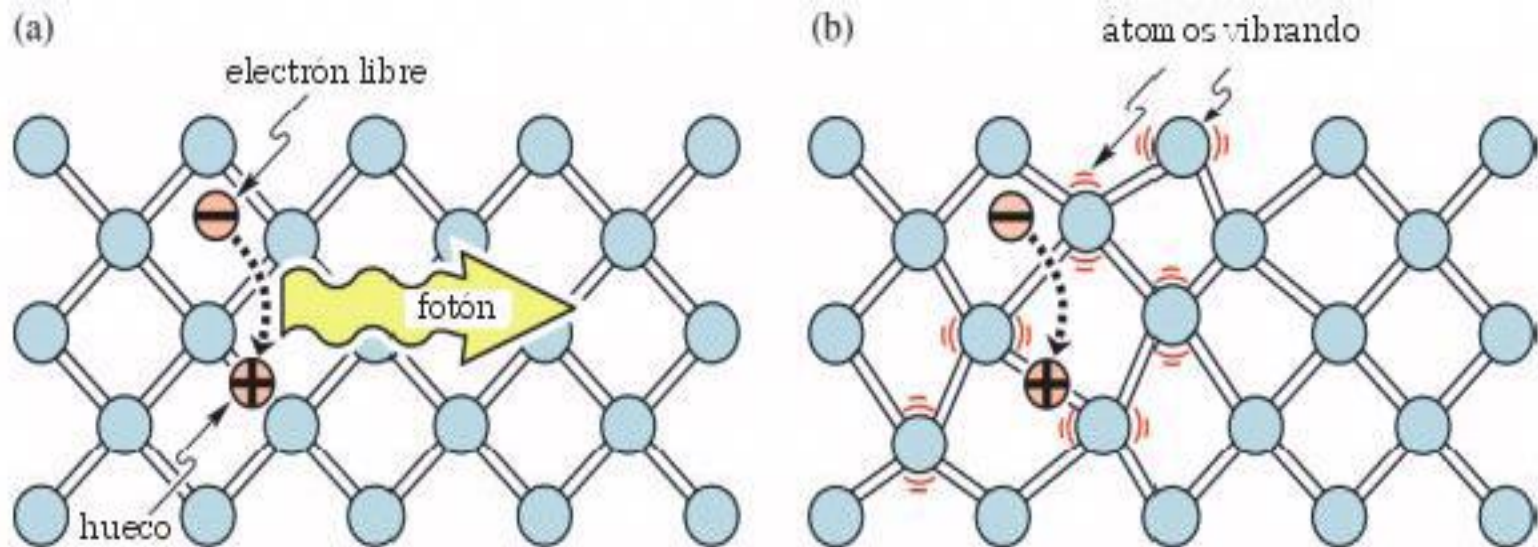


# Transición del Electrón

## En un Semiconductor

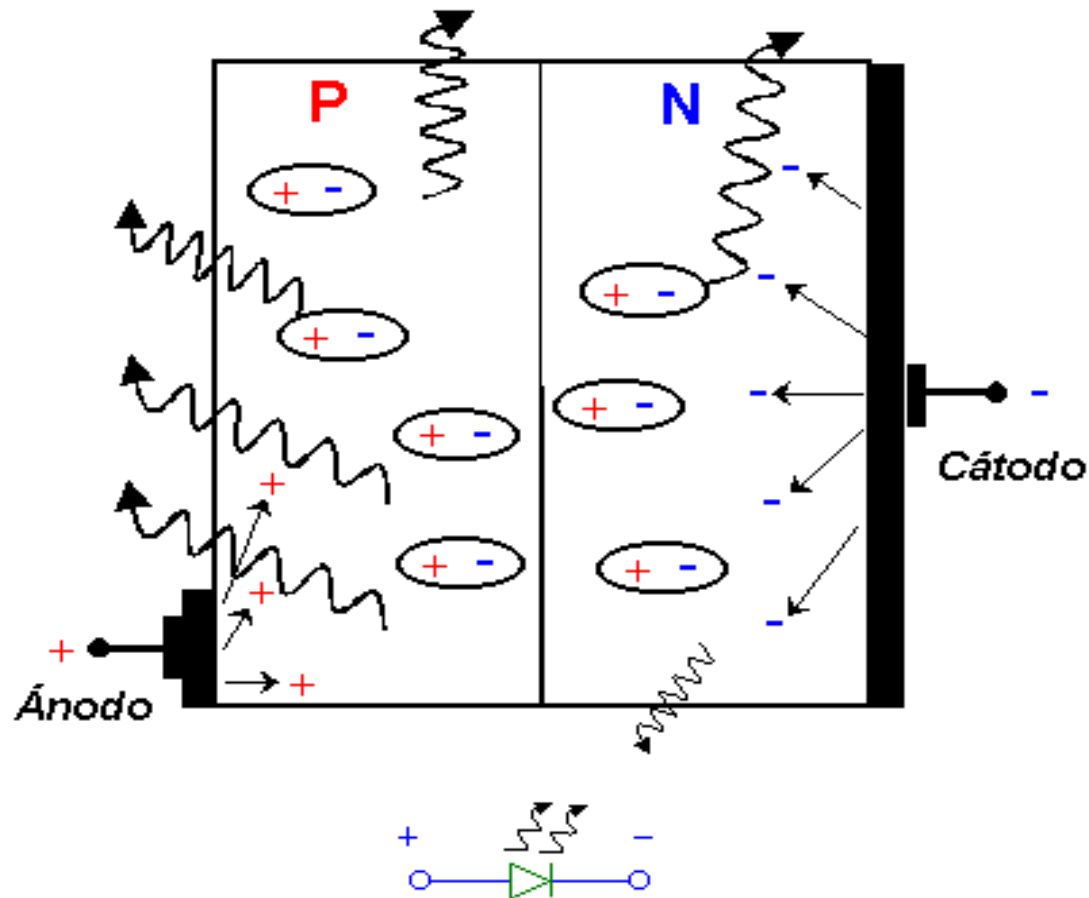


# Emisión de LUZ



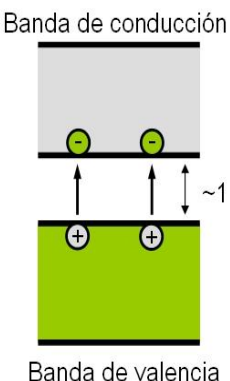
La energía que se pierde en una unión PII, cuando tiene lugar una recombinación se transforma en dos tipos:  
a) liberación de fotones (ondas electromagnéticas) b) calor (agitación de átomos)

# LED: Emisión de LUZ



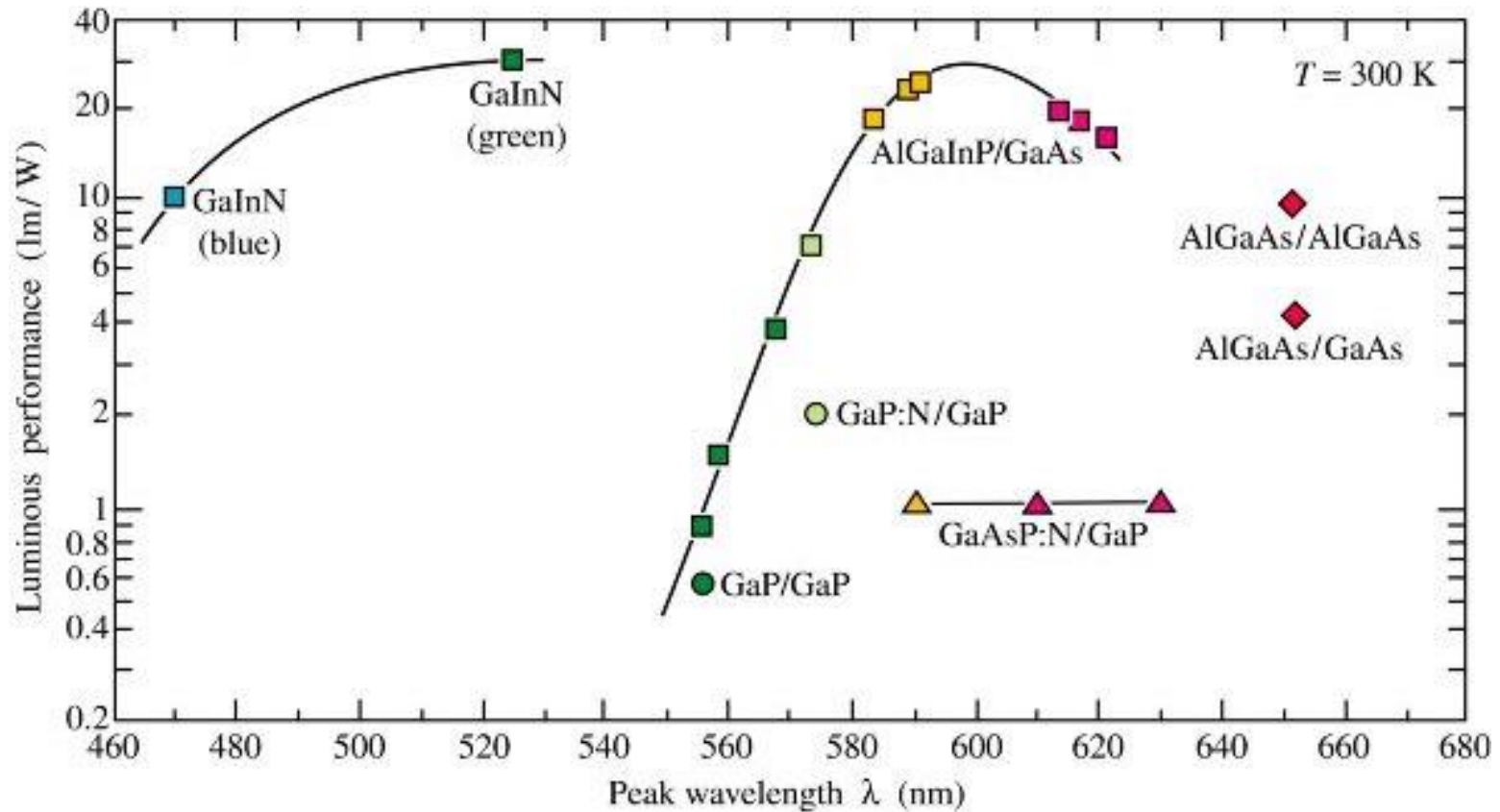
|                                                      |       |                                                      |       |                                                      |       |                                                      |       |                                                      |       |                                                      |            |
|------------------------------------------------------|-------|------------------------------------------------------|-------|------------------------------------------------------|-------|------------------------------------------------------|-------|------------------------------------------------------|-------|------------------------------------------------------|------------|
| IIIa                                                 |       | IVa                                                  |       | Va                                                   |       | VIa                                                  |       | VIIa                                                 |       | 4.22<br>0.93                                         | 31.8<br>1s |
| 5                                                    | B     | 6                                                    | C     | 7                                                    | N     | 8                                                    | O     | 9                                                    | F     | 10                                                   | Ne         |
| 10,811                                               |       | 12,0107                                              |       | 14,00674                                             |       | 15,9994                                              |       | 18,998403                                            |       | 20,1797                                              |            |
| Boro                                                 |       | Carbono                                              |       | Nitrógeno                                            |       | Oxígeno                                              |       | Flúor                                                |       | Neón                                                 |            |
| 3                                                    | 1.026 | -4.2.4                                               | 0.710 | -3.2.3.4.5                                           | 1.04  | -2                                                   | 0.92  | -1                                                   | 0.824 | -                                                    | 1.03       |
| 2.34                                                 | 2.04  | 2.26                                                 | 2.55  | 1.251                                                | 3.04  | 1.429                                                | 3.44  | 1.696                                                | 3.98  | 0.900                                                | -          |
| 2365                                                 | 801   | 4100                                                 | 1087  | 63.15                                                | 1402  | 54.8                                                 | 1314  | 53.48                                                | 1681  | 24.55                                                | 2081       |
| 4275                                                 | 4.6   | 5100                                                 | 4.6   | 77.35                                                | 17.3  | 90.18                                                | 14.0  | 84.95                                                | 17.1  | 27.1                                                 | 16.7       |
| 0.82                                                 |       | 0.77                                                 |       | 0.75                                                 |       | 0.73                                                 |       | 0.72                                                 |       | 0.71                                                 |            |
| [He]2s <sup>2</sup> 2p <sup>1</sup>                  |       | [He]2s <sup>2</sup> 2p <sup>2</sup>                  |       | [He]2s <sup>2</sup> 2p <sup>3</sup>                  |       | [He]2s <sup>2</sup> 2p <sup>4</sup>                  |       | [He]2s <sup>2</sup> 2p <sup>5</sup>                  |       | [He]2s <sup>2</sup> 2p <sup>6</sup>                  |            |
| 13                                                   | Al    | 14                                                   | Si    | 15                                                   | P     | 16                                                   | S     | 17                                                   | Cl    | 18                                                   | Ar         |
| 26,981538                                            |       | 28,0855                                              |       | 30,973761                                            |       | 32,066                                               |       | 35,4527                                              |       | 39,948                                               |            |
| Aluminio                                             |       | Silicio                                              |       | Fósforo                                              |       | Azufre                                               |       | Cloro                                                |       | Argón                                                |            |
| 3                                                    | 0.904 | 4                                                    | 0.712 | -3.3.4.5                                             | 0.770 | -2.2.4.6                                             | 0.705 | -1.1.3.5.7                                           | 0.478 | -                                                    | 0.52       |
| 2.70                                                 | 1.61  | 2.33                                                 | 1.9   | 1.82                                                 | 2.19  | 2.07                                                 | 2.58  | 3.214                                                | 3.16  | 1.784                                                | -          |
| 933.5                                                | 578   | 1683                                                 | 787   | 317.3                                                | 1012  | 388.4                                                | 1000  | 172.2                                                | 1251  | 83.8                                                 | 1521       |
| 2793                                                 | 10.0  | 3540                                                 | 12.1  | 550                                                  | 17.0  | 717.8                                                | 15.5  | 239.1                                                | 18.7  | 87.3                                                 | 24.2       |
| 1.18                                                 |       | 1.11                                                 |       | 1.06                                                 |       | 1.02                                                 |       | 0.99                                                 |       | 0.98                                                 |            |
| [Ne]3s <sup>2</sup> 3p <sup>1</sup>                  |       | [Ne]3s <sup>2</sup> 3p <sup>2</sup>                  |       | [Ne]3s <sup>2</sup> 3p <sup>3</sup>                  |       | [Ne]3s <sup>2</sup> 3p <sup>4</sup>                  |       | [Ne]3s <sup>2</sup> 3p <sup>5</sup>                  |       | [Ne]3s <sup>2</sup> 3p <sup>6</sup>                  |            |
| 31                                                   | Ga    | 32                                                   | Ge    | 33                                                   | As    | 34                                                   | Se    | 35                                                   | Br    | 36                                                   | Kr         |
| 69,723                                               |       | 72,61                                                |       | 74,92160                                             |       | 78,96                                                |       | 79,904                                               |       | 83,8                                                 |            |
| Galio                                                |       | Germanio                                             |       | Arsénico                                             |       | Selenio                                              |       | Bromo                                                |       | Kriptón                                              |            |
| 3                                                    | 0.371 | 4                                                    | 0.322 | -3.3.5                                               | 0.328 | -2.4.6                                               | 0.321 | -1.1.5                                               | 0.473 | -                                                    | 0.248      |
| 5.91                                                 | 1.81  | 5.32                                                 | 2.01  | 5.72                                                 | 2.18  | 4.79                                                 | 2.55  | 3.12                                                 | 2.96  | 3.7                                                  | -          |
| 302.9                                                | 579   | 1211.5                                               | 762   | 1090 (36Atm)                                         | 947   | 494                                                  | 941   | 265.9                                                | 1140  | 115.8                                                | 1351       |
| 2478                                                 | 11.8  | 3107                                                 | 13.6  | 886 (Sublim)                                         | 13.1  | 958                                                  | 16.5  | 332.2                                                | 23.5  | 119.8                                                | 32.2       |
| 1.26                                                 |       | 1.22                                                 |       | 1.20                                                 |       | 1.16                                                 |       | 1.14                                                 |       | 1.12                                                 |            |
| [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>1</sup> |       | [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>2</sup> |       | [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>3</sup> |       | [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>4</sup> |       | [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>5</sup> |       | [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>6</sup> |            |
| 48                                                   | In    | 50                                                   | Sn    | 51                                                   | Sb    | 52                                                   | Te    | 53                                                   | I     | 54                                                   | Xe         |
| 114,818                                              |       | 118,71                                               |       | 121,760                                              |       | 127,60                                               |       | 126,90447                                            |       | 131,29                                               |            |
| Indio                                                |       | Estaño                                               |       | Antimonio                                            |       | Teluro                                               |       | Yodo                                                 |       | Xenón                                                |            |
| 3                                                    | 0.233 | 2.4                                                  | 0.228 | -3.3.5                                               | 0.207 | -2.4.6                                               | 0.201 | -1.1.5.7                                             | 0.214 | -                                                    | 0.158      |
| 7.31                                                 | 1.78  | 7.31                                                 | 1.96  | 6.69                                                 | 2.05  | 6.24                                                 | 2.1   | 4.93                                                 | 2.66  | 5.9                                                  | 2.6        |
| 429.8                                                | 558   | 505.1                                                | 709   | 904                                                  | 834   | 722.7                                                | 869   | 386.7                                                | 1008  | 161.4                                                | 1170       |
| 2346                                                 | 15.7  | 2876                                                 | 16.3  | 1860                                                 | 18.4  | 1261                                                 | 20.5  | 458.4                                                | 25.7  | 165.1                                                | 42.9       |
| 1.44                                                 |       | 1.41                                                 |       | 1.40                                                 |       | 1.36                                                 |       | 1.33                                                 |       | 1.31                                                 |            |
| [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>1</sup> |       | [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>2</sup> |       | [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>3</sup> |       | [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>4</sup> |       | [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>5</sup> |       | [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>6</sup> |            |

# Compuestos Empleados en la Construcción de los LED



| Compuesto                              | Color                       | Long. de onda |
|----------------------------------------|-----------------------------|---------------|
| arseniuro de galio (GaAs)              | Infrarrojo                  | 940 nm        |
| arseniuro de galio y aluminio (AlGaAs) | rojo e infrarrojo           | 890 nm        |
| arseniuro fosfuro de galio (GaAsP)     | rojo, anaranjado y amarillo | 630 nm        |
| fosfuro de galio (GaP)                 | verde                       | 555 nm        |
| nitruro de galio (GaN)                 | verde                       | 525 nm        |
| seleniuro de cinc (ZnSe)               | azul                        |               |
| nitruro de galio e indio (InGaN)       | azul                        | 450 nm        |
| carburo de silicio (SiC)               | azul                        | 480 nm        |
| diamante (C)                           | ultravioleta                |               |
| silicio (Si)                           | en desarrollo               |               |

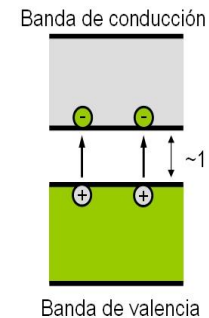
# Materiales del LED



# TENSION de los LED

## Según su Color

| LONGITUD DE ONDA [nm] |            | TENSION [V] |
|-----------------------|------------|-------------|
| 565                   | VERDE      | 2,2 - 3,0   |
| 590                   | AMARILLO   | 2,2 - 3,0   |
| 615                   | NARANJA    | 1,8 - 2,7   |
| 640                   | ROJO       | 1,6 - 2,0   |
| 690                   | ROJO       | 2,2 - 3,0   |
| 880                   | INFRARROJO | 2,0 - 2,5   |
| 900                   | INFRARROJO | 1,2 - 1,6   |
| 940                   | INFRARROJO | 1,3 - 1,7   |

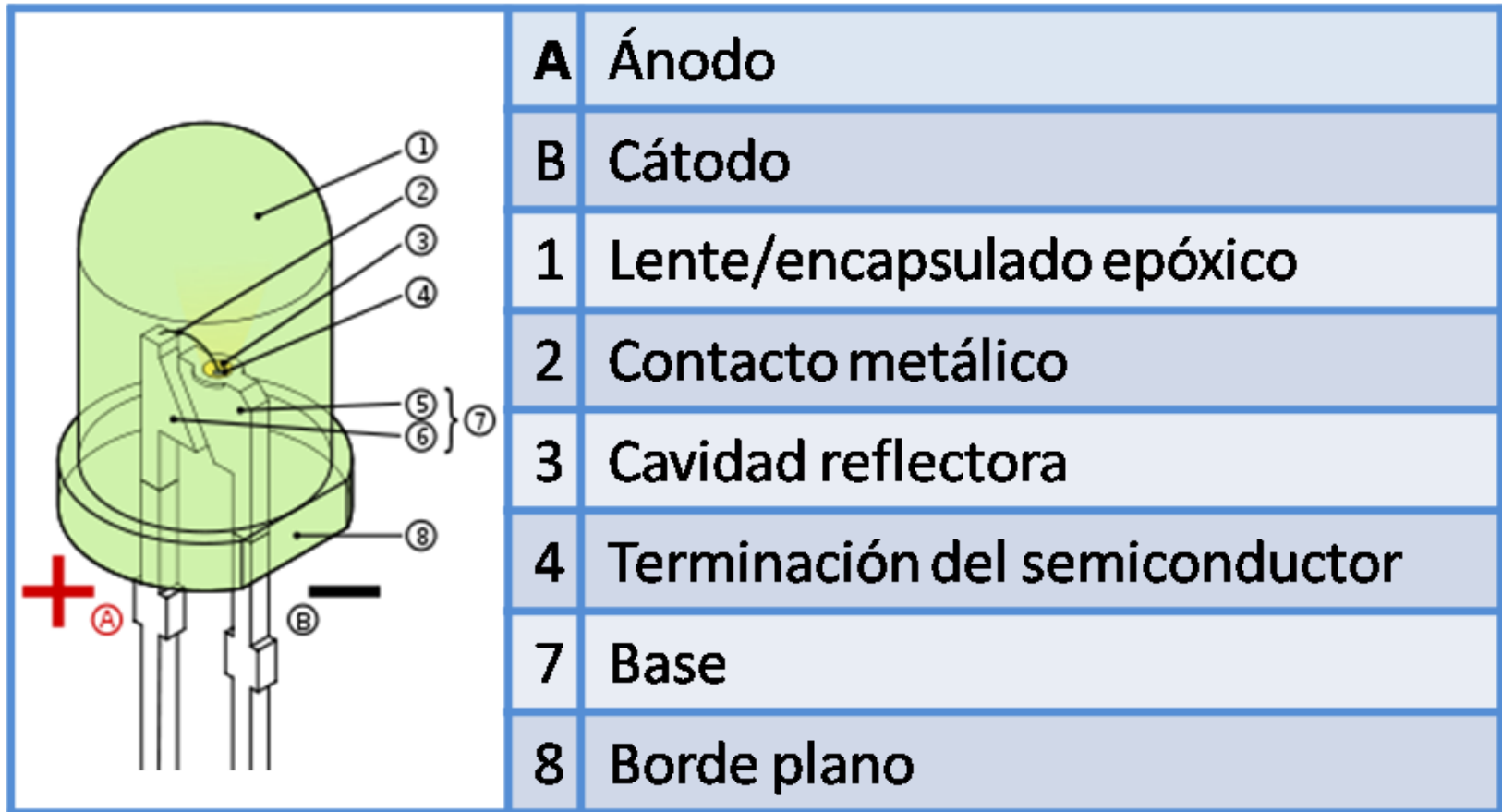


# TENSION de los LED

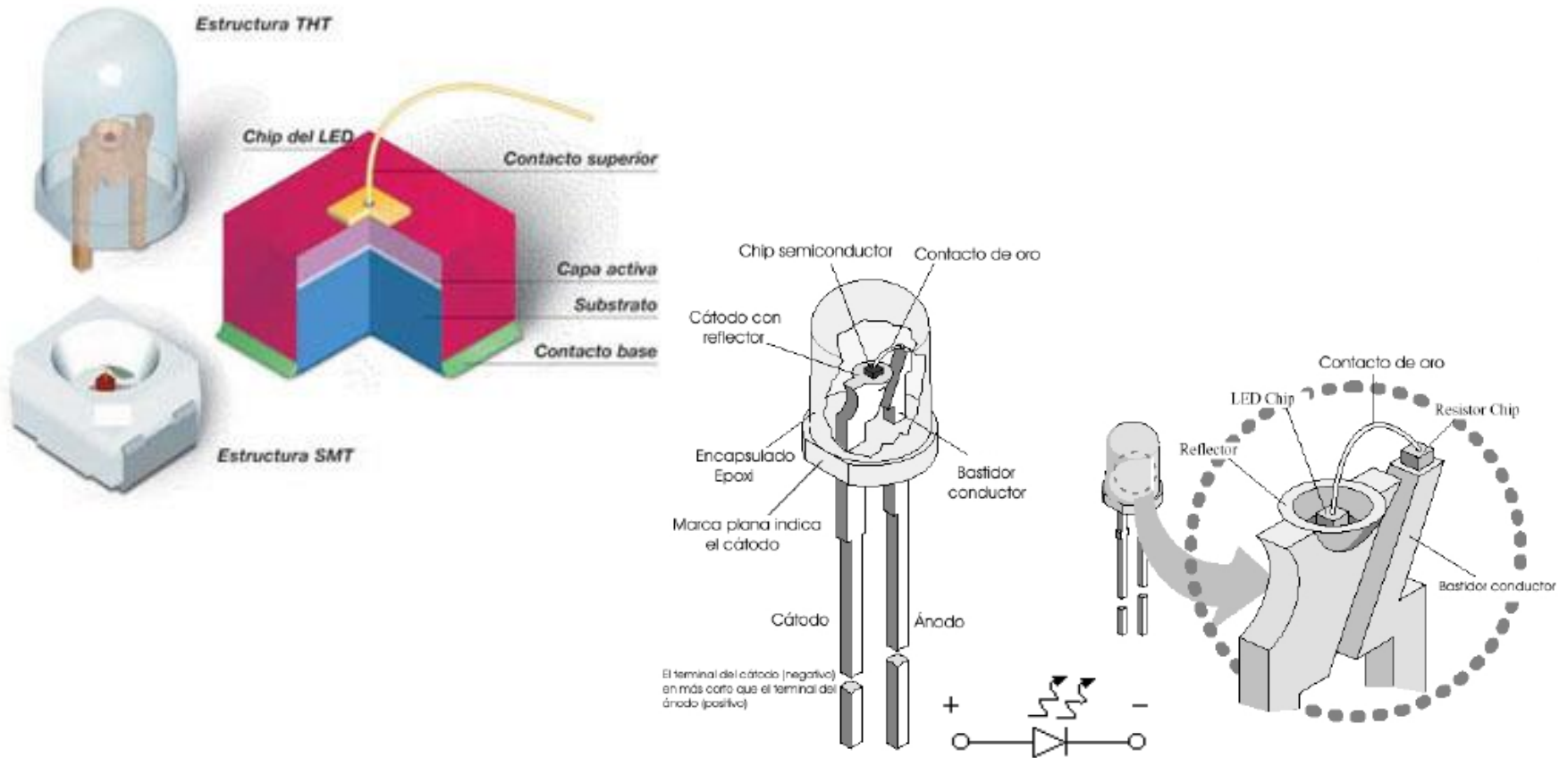
## Según su Color (Otros colores)

| Color        |                                                                                     | Long. de onda (nm)    | Voltaje (V)              |
|--------------|-------------------------------------------------------------------------------------|-----------------------|--------------------------|
| Infrarrojo   |    | $\lambda > 760$       | $\Delta V < 1,63$        |
| Rojo         |    | $610 < \lambda < 760$ | $1,63 < \Delta V < 2,03$ |
| Naranja      |    | $590 < \lambda < 610$ | $2,03 < \Delta V < 2,10$ |
| Amarillo     |    | $570 < \lambda < 590$ | $2,10 < \Delta V < 2,18$ |
| Verde        |    | $500 < \lambda < 570$ | $1,90 < \Delta V < 4,00$ |
| Azul         |    | $450 < \lambda < 500$ | $2,48 < \Delta V < 3,70$ |
| Violeta      |    | $400 < \lambda < 450$ | $2,76 < \Delta V < 4,00$ |
| Morado       |   | Varios tipos          | $2,48 < \Delta V < 3,70$ |
| Ultravioleta |  | $\lambda < 400$       | $3,10 < \Delta V < 4,40$ |
| Rosa         |  | Varios tipos          | $\Delta V$ aprox. 3,3    |
| Blanco       |  | Todo el espectro      | $\Delta V$ aprox. 3,5    |

# LED



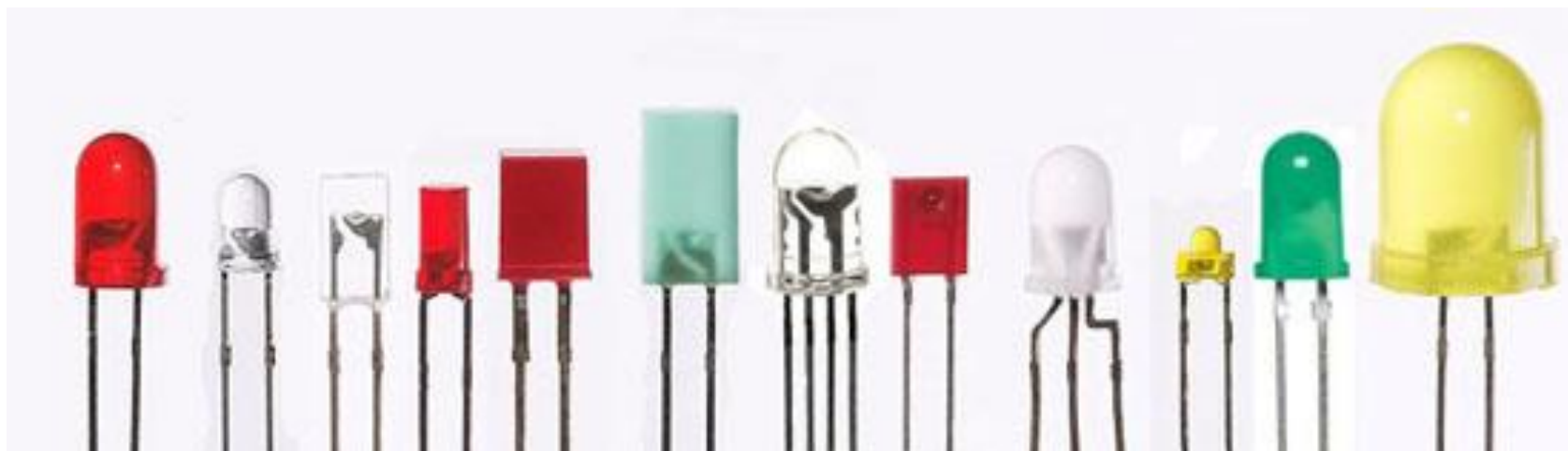
# LED: Conexión Interna



# Tipos de LED



**Fig 1.1: Distintos tipos de LED**





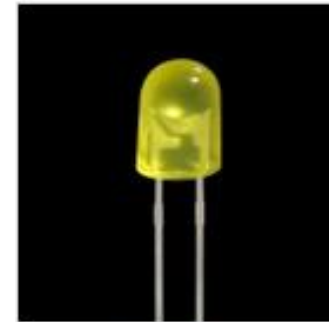
Degradation Resistant Blue



Subminiature LED



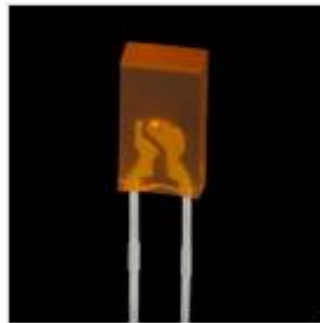
Round LED



Oval LED



Flat Top LED



Rectangular LED



Cylindrical LED



Multi-Color LED



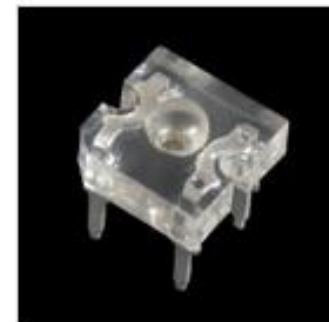
Resistor LED



Low Current LED



Blinking LED



Super Flux LED

# Tipos de LED

<http://www.kingbright.com/>



Cylindrical Bi-Color



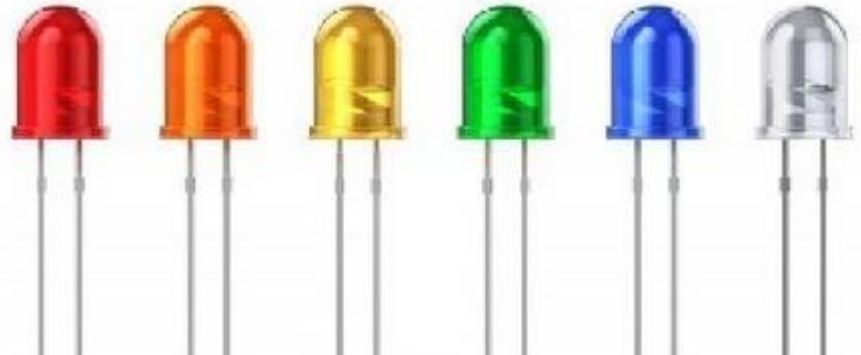
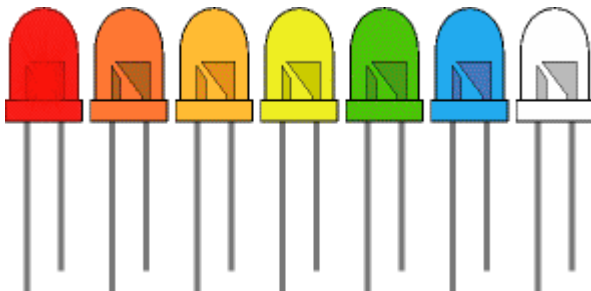
Rectangular Bi-Color



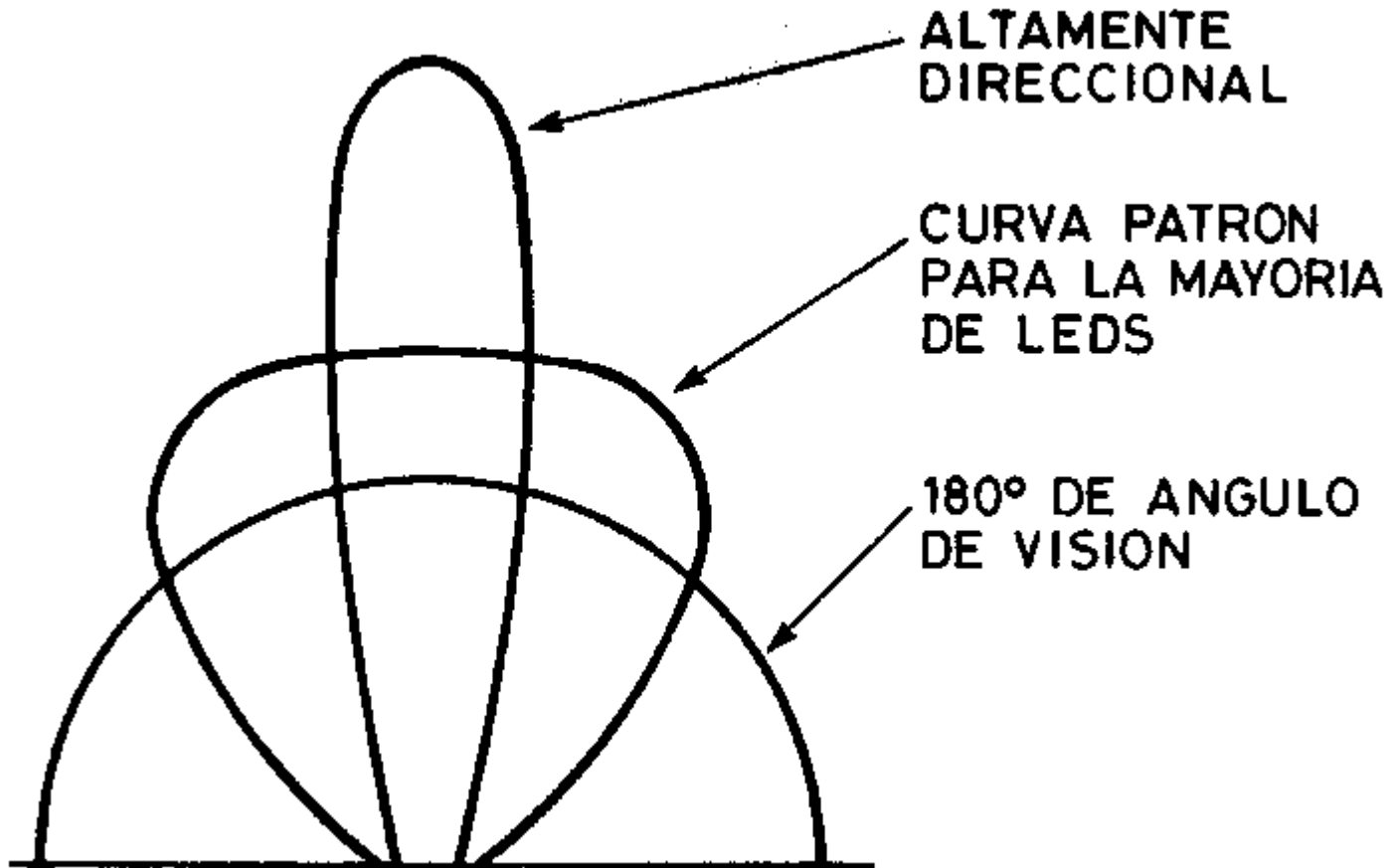
Round Bi-Color



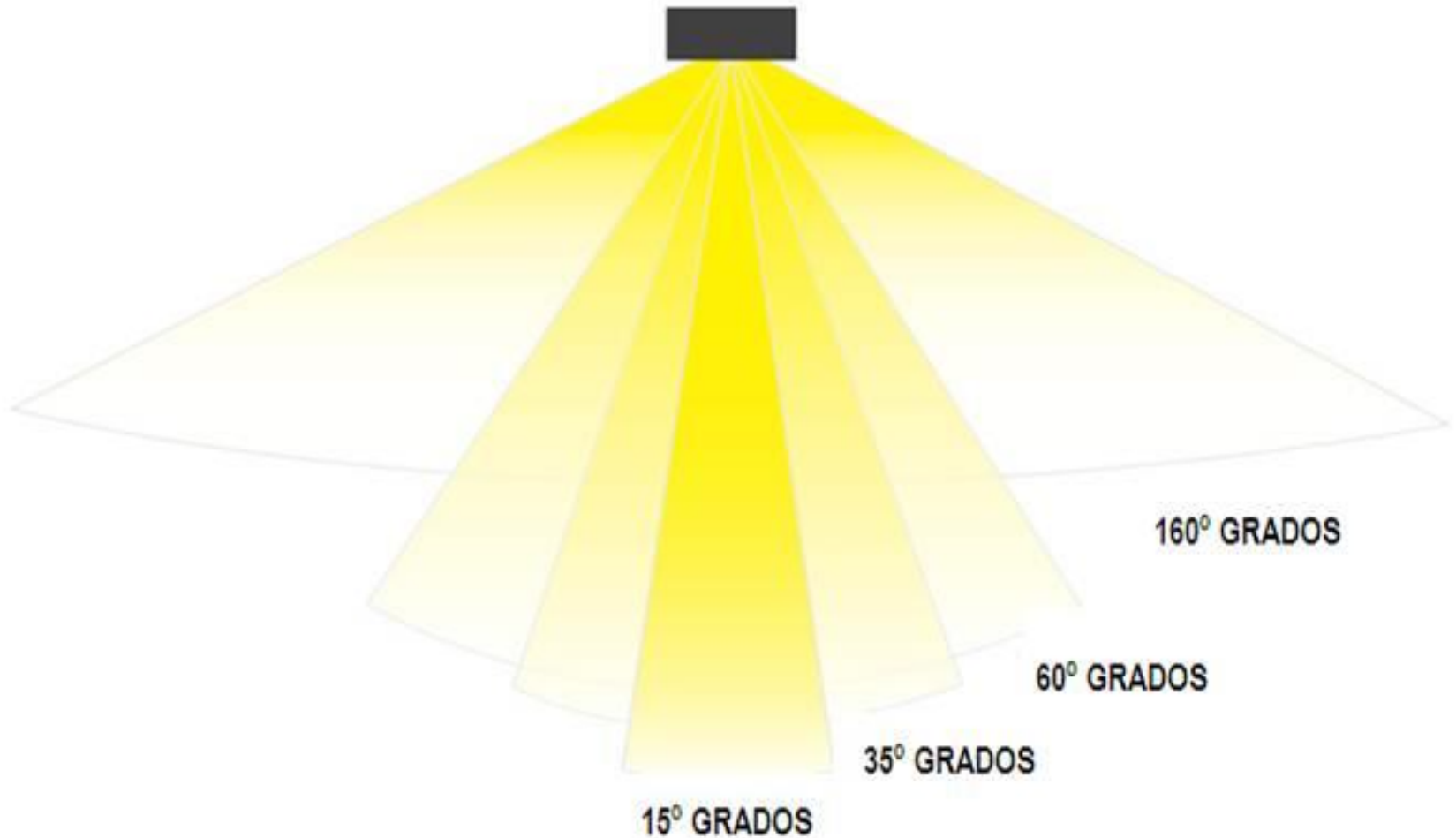
Round Full Color



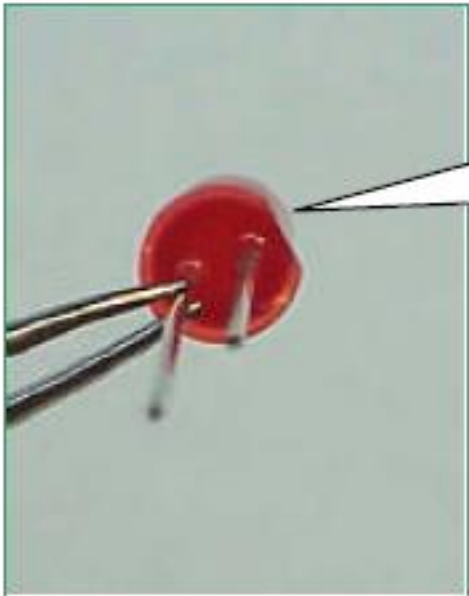
# Angulo de Irradiación



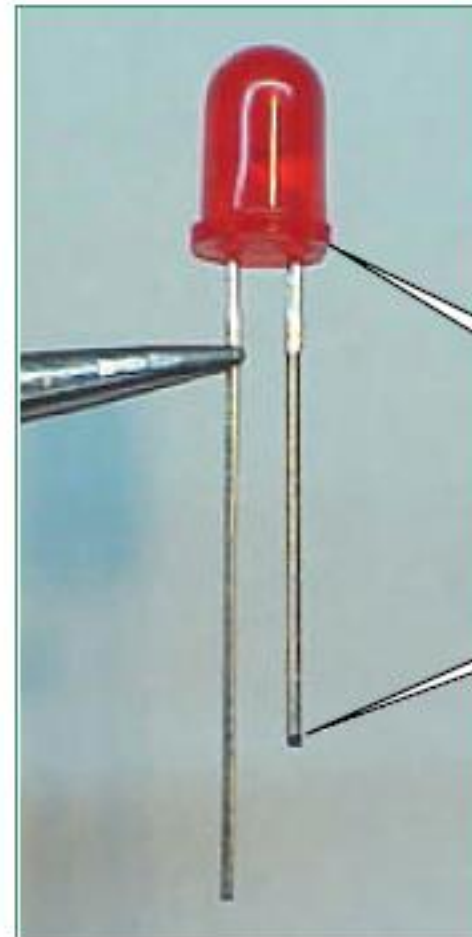
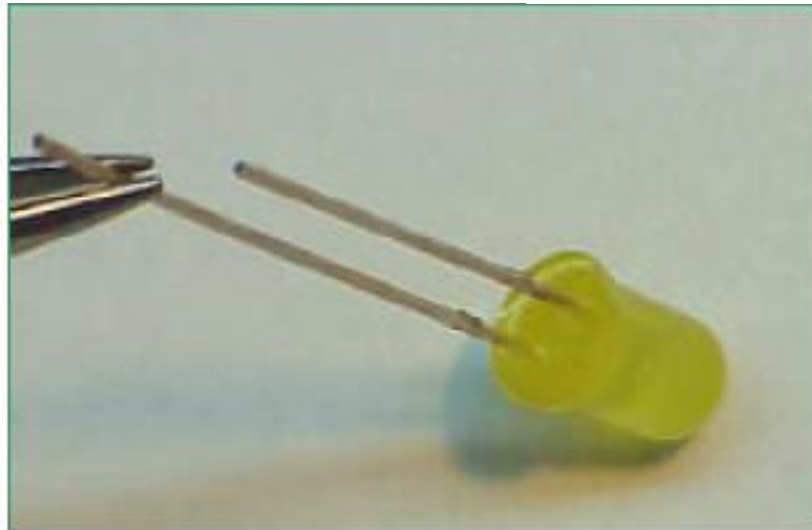
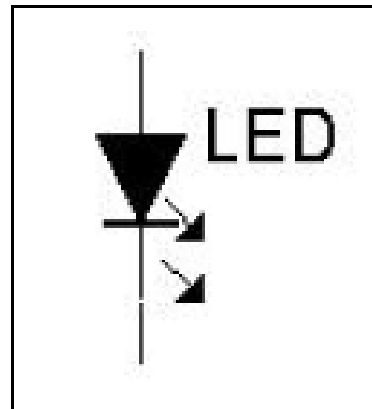
# Angulo de Irradiación



# IDENTIFICACION DE TERMINALES

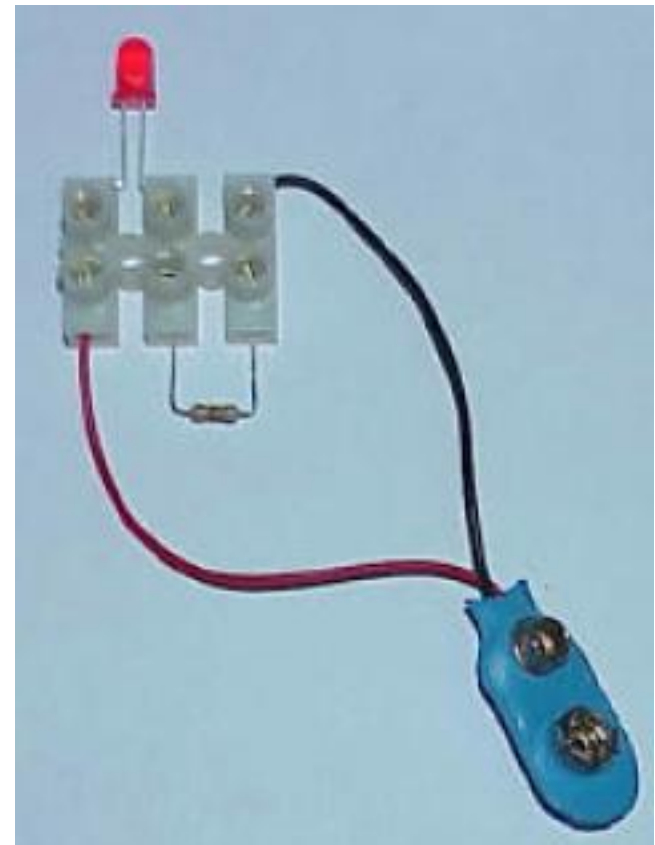
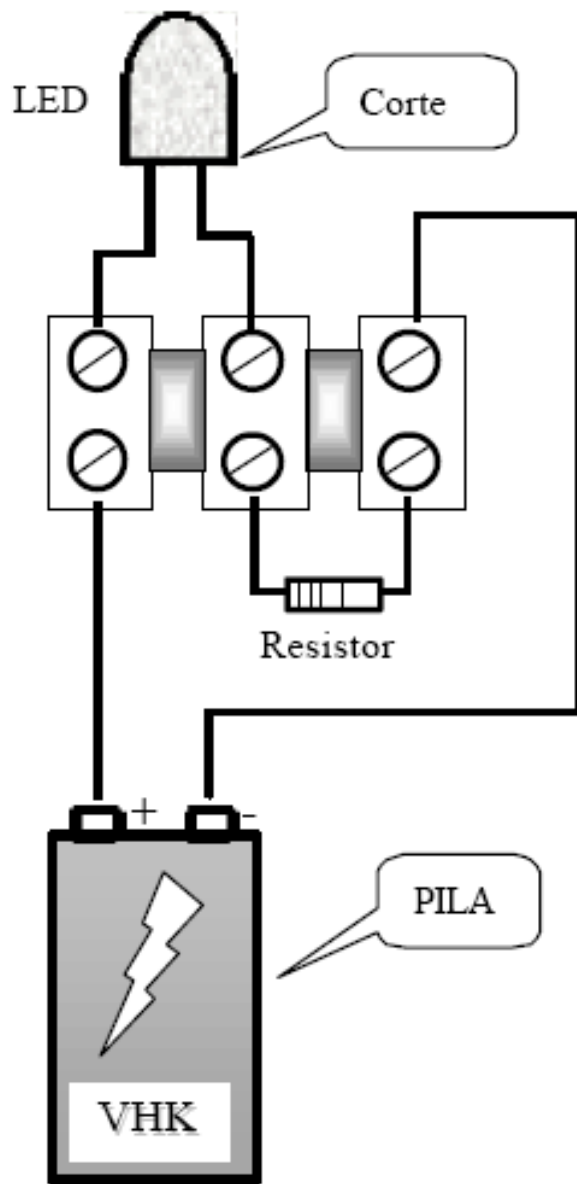


Corte que indica el cátodo

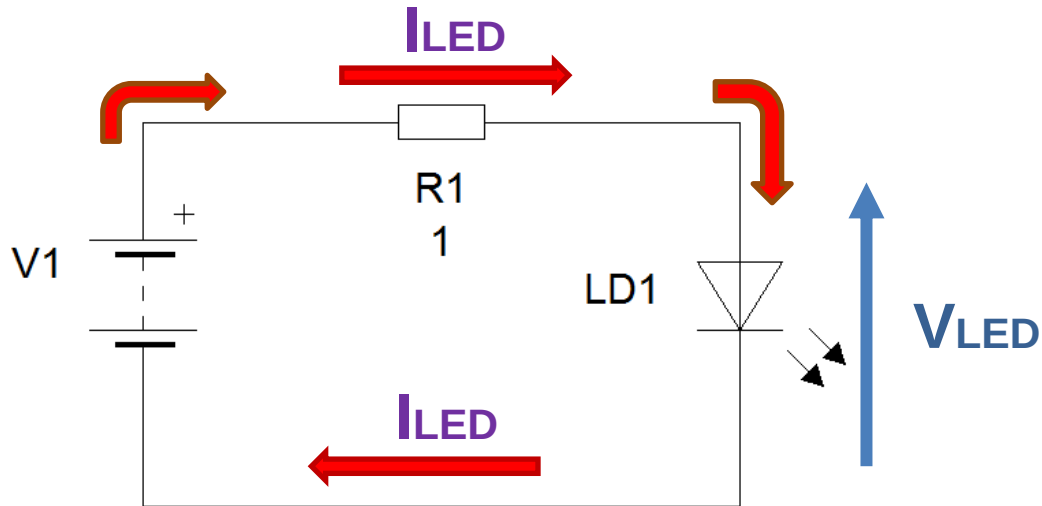


Corte

Cátodo

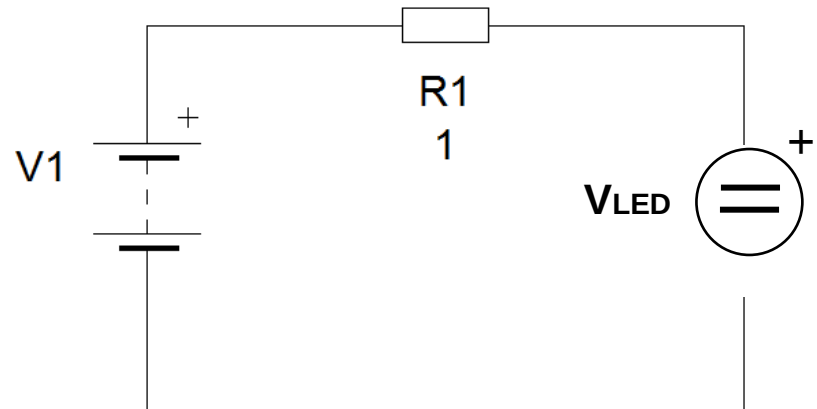


# Como Conectar un LED

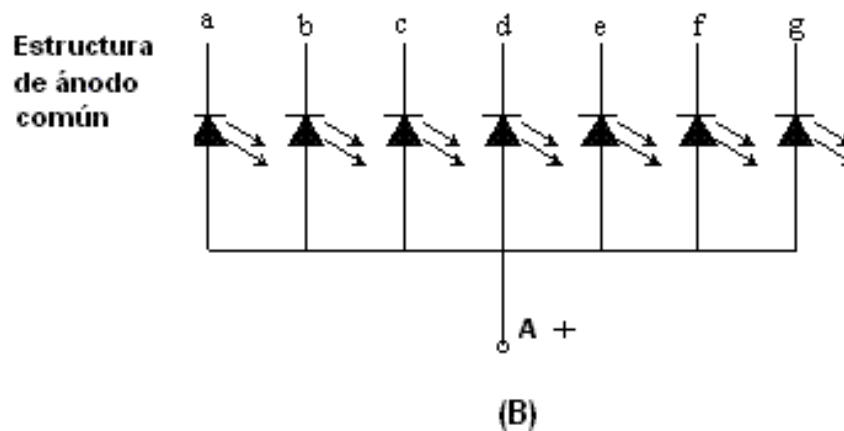
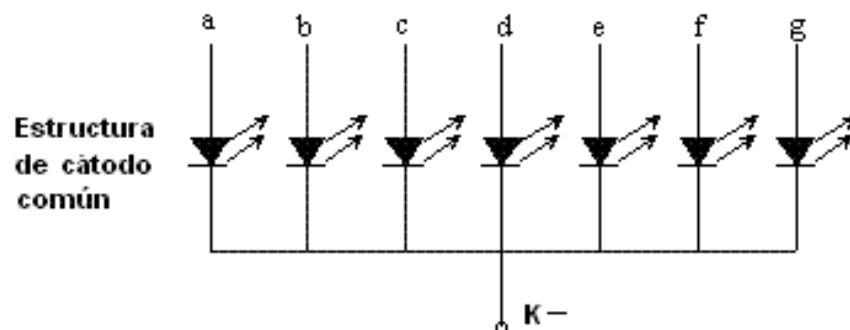
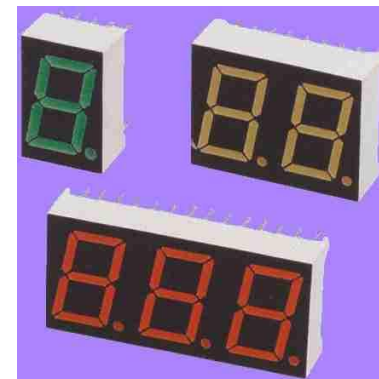
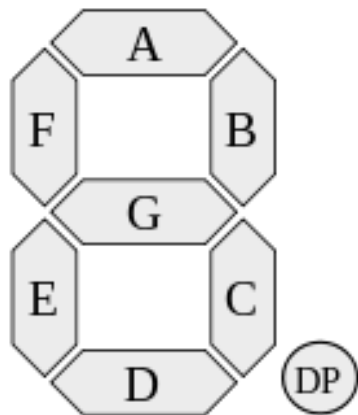
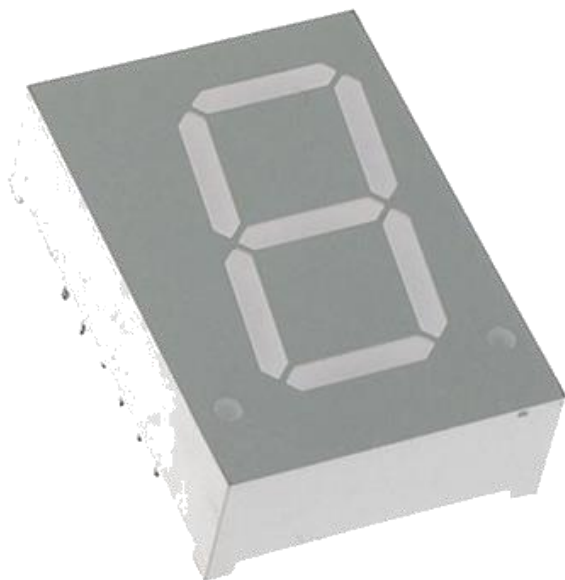


$$R_1 = \frac{V_1 - V_{LED}}{I_{LED}}$$

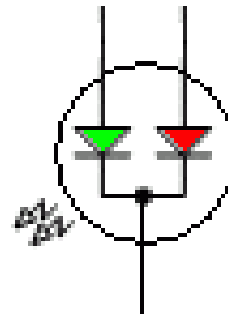
$$\left\{ \begin{array}{l} V_{led} = 2 \text{ Vdc} \\ I_{led} = 20 \text{ mA} \end{array} \right.$$



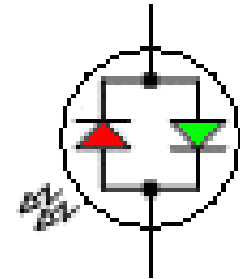
# Display 7 Segmentos



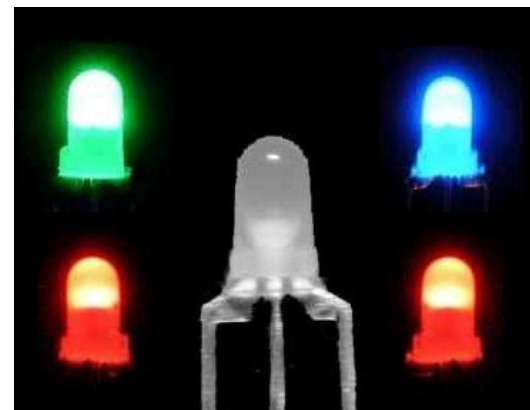
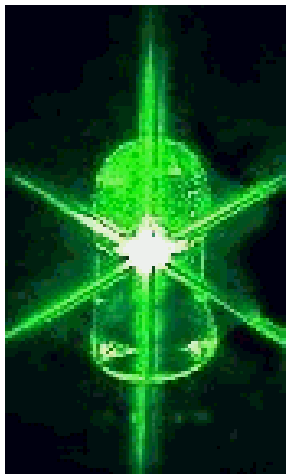
# LED Bicolor



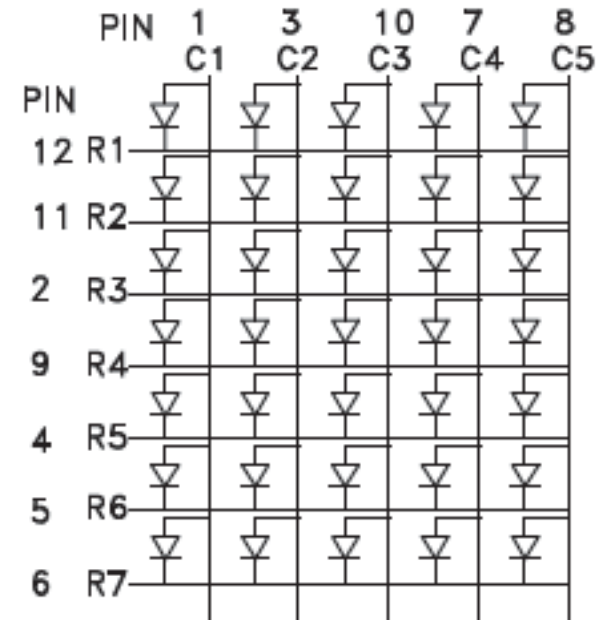
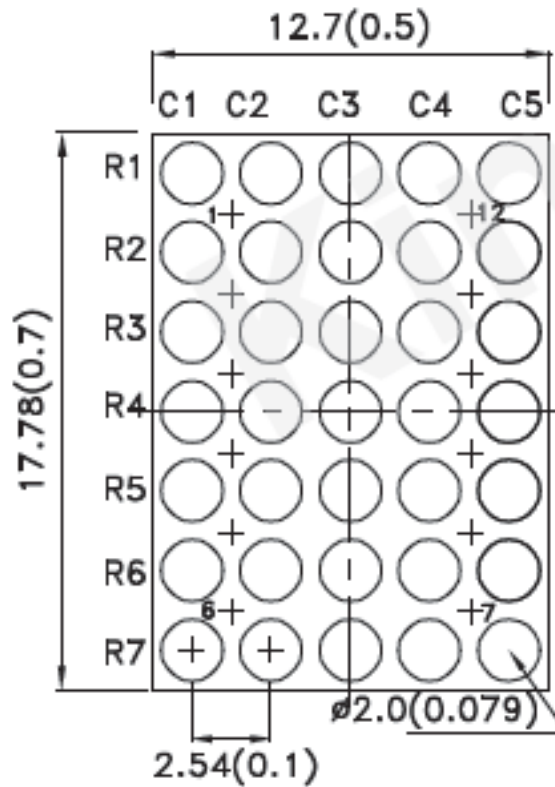
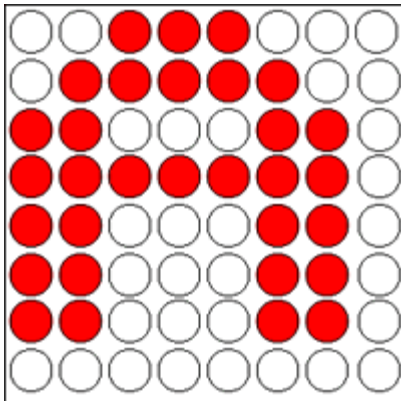
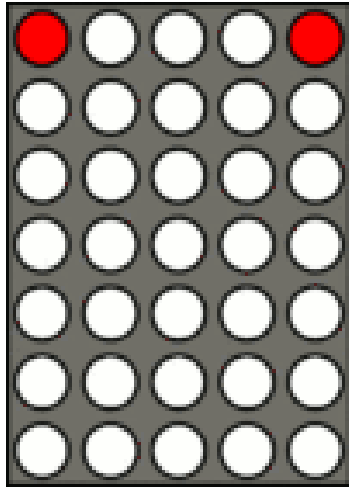
**bicolor  
catodo comum**



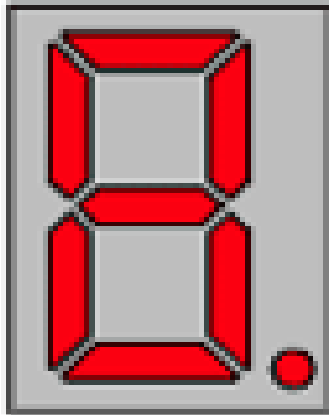
**bicolor  
bipolar**



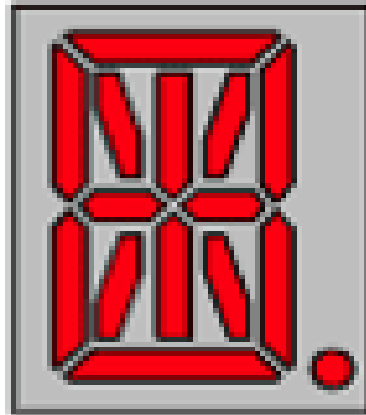
# MATRICES DE LED



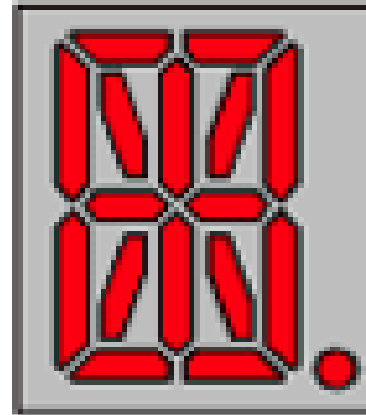
# Display Alfanuméricos



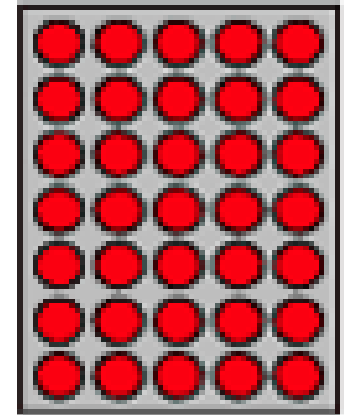
7-Segment  
plus DP



14-Segment  
plus DP



16-Segment  
plus DP

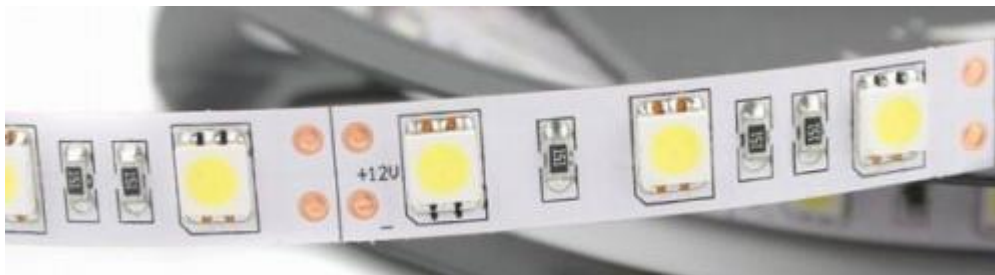
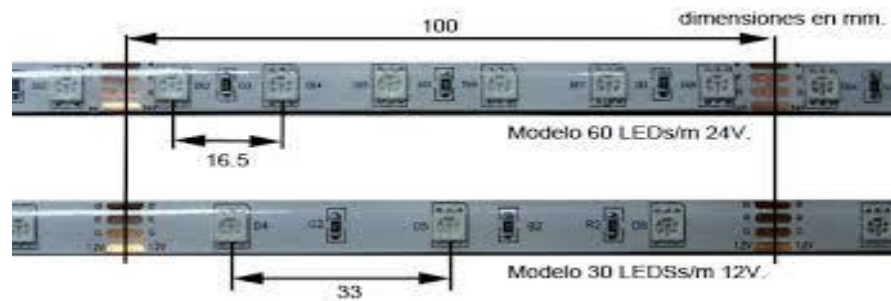
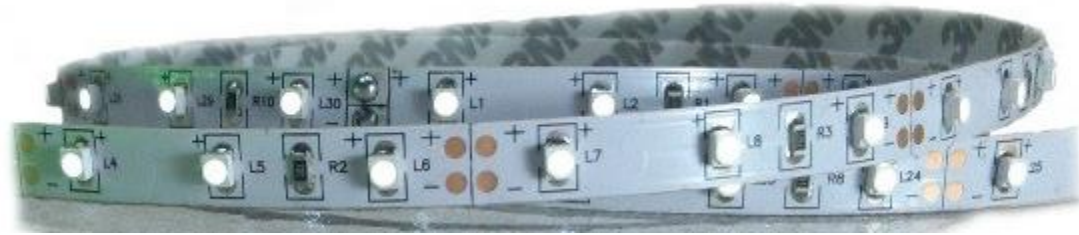


5 x 7 Matrix

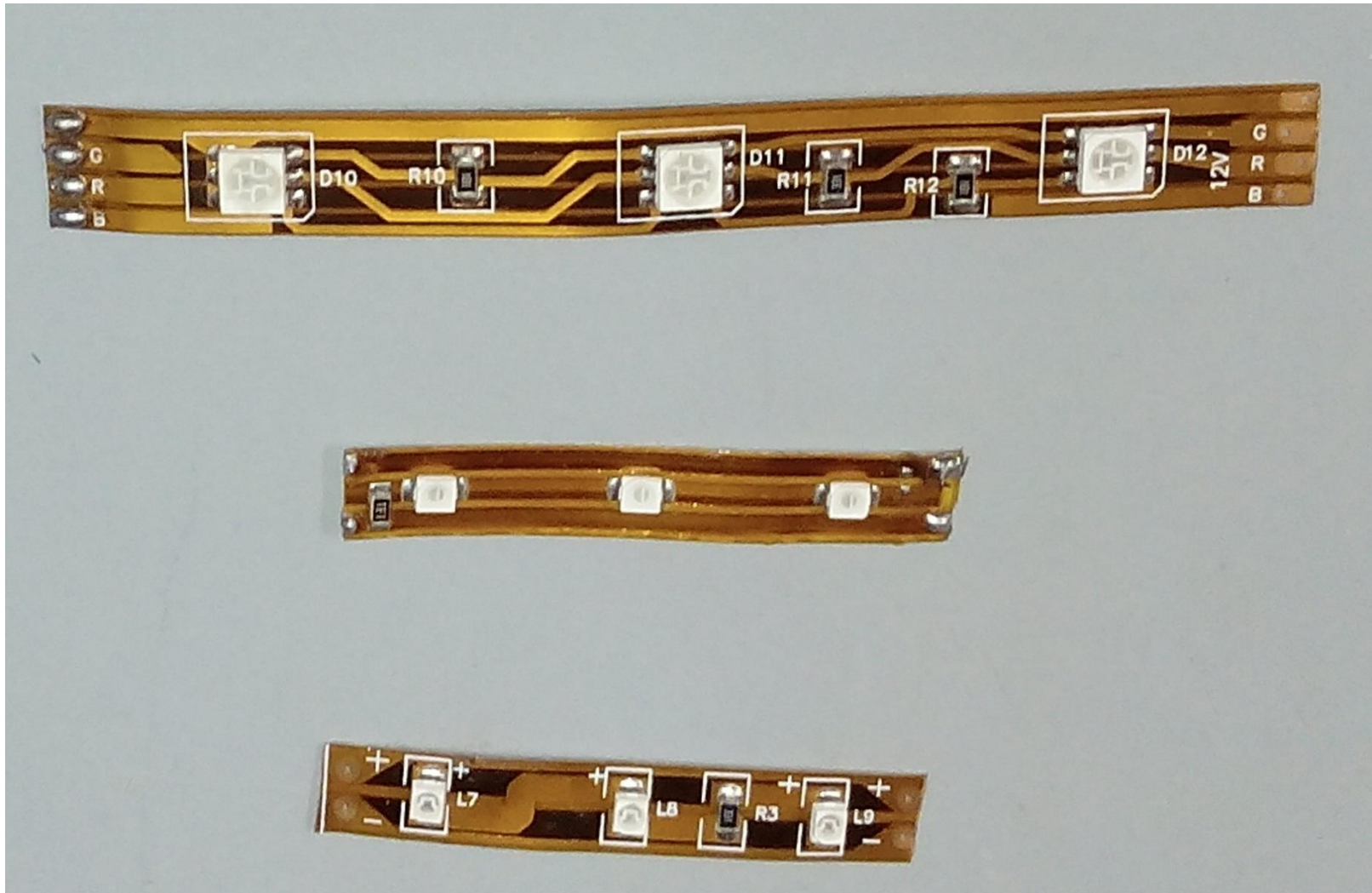
# CINTA DE LED



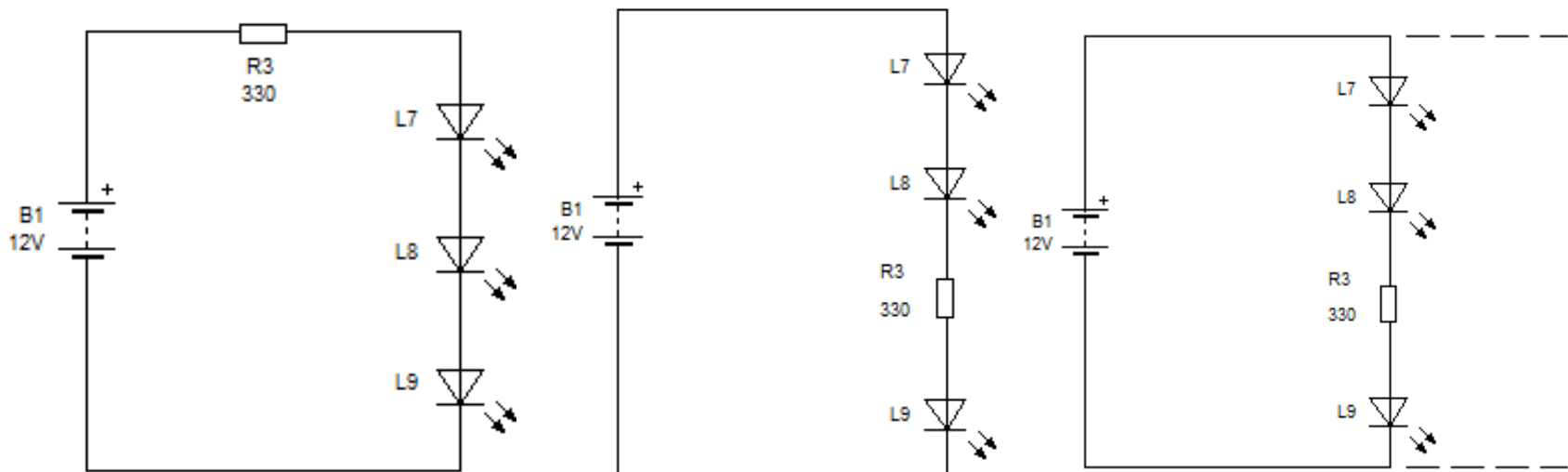
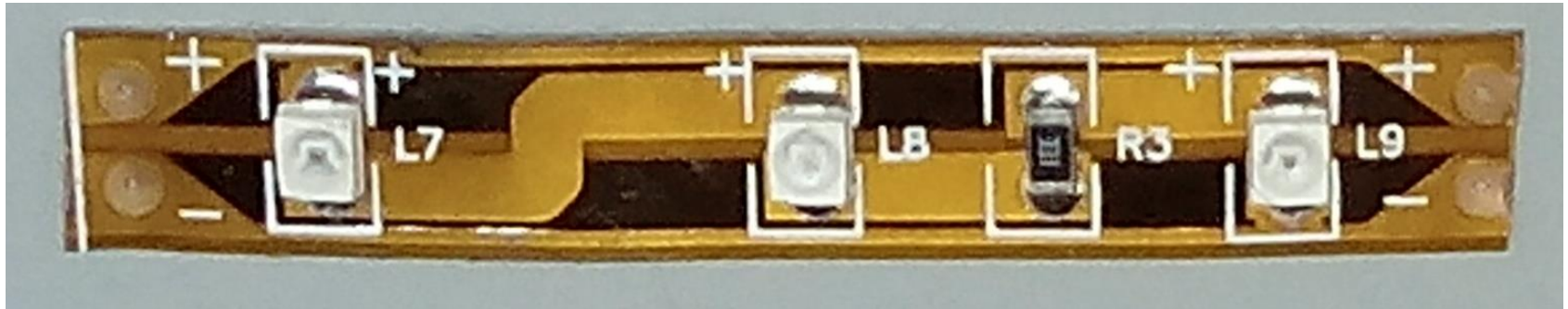
# CINTA DE LED



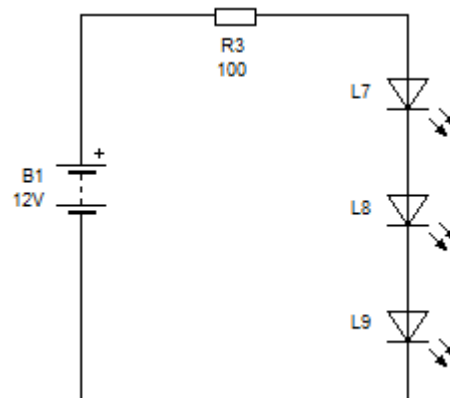
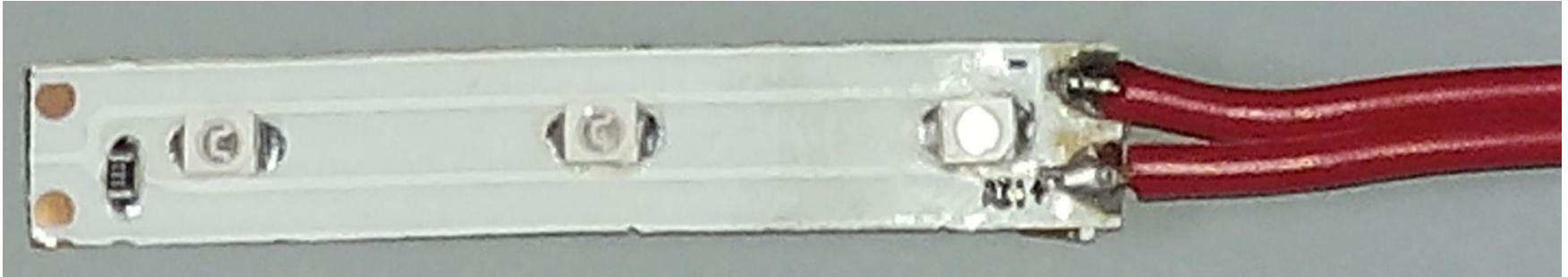
# CINTA DE LED



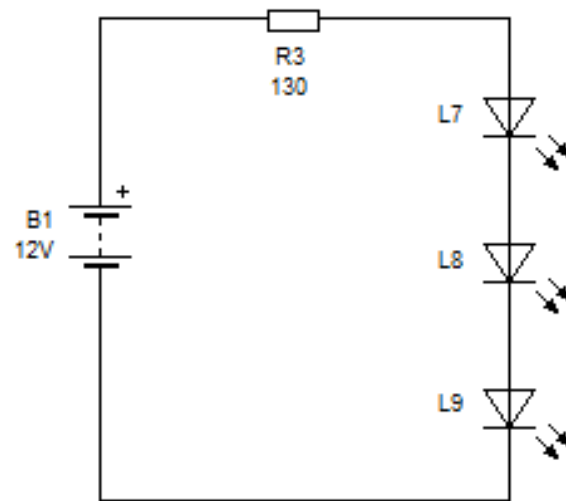
# CINTA DE LED



# CINTA DE LED

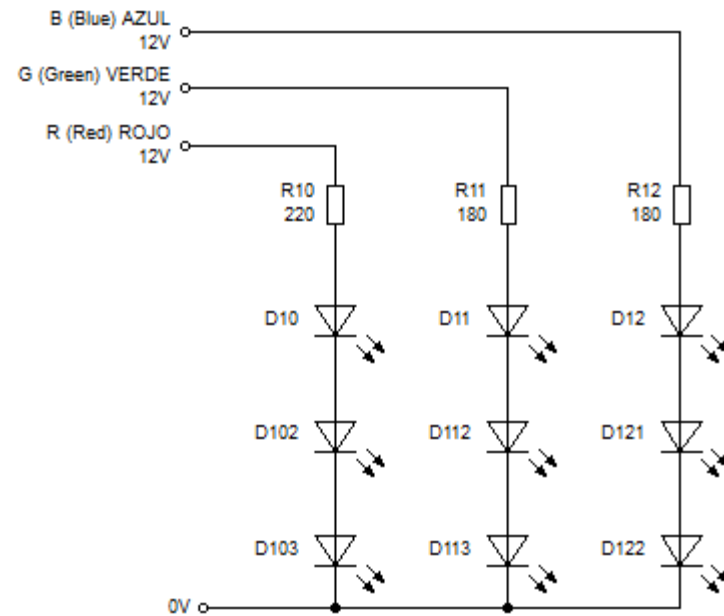
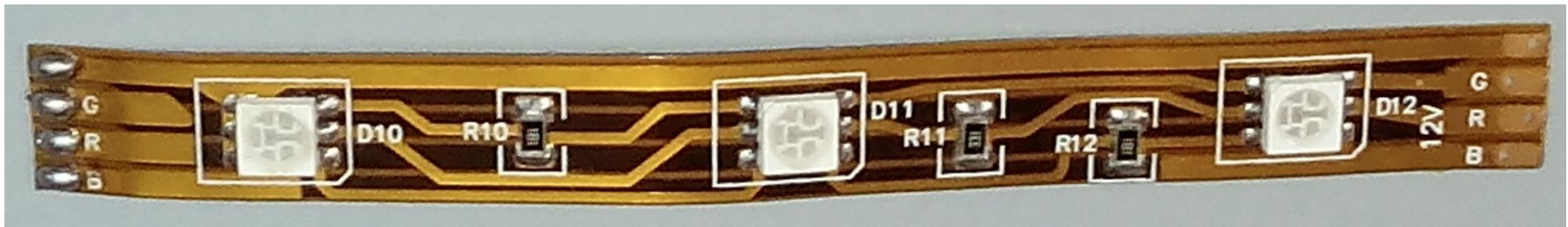


# CINTA DE LED

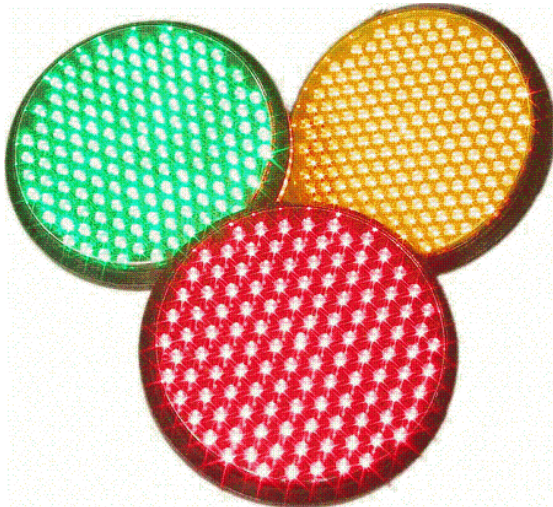


# CINTA DE LED

## Tipo RGB



# LED Otras Presentaciones



# FIN

