Optoelectronic Device Notes

Reference: Scherz & Monk *Practical Electronics for Inventors*

	3rd Edition	4th Edition
LED Specifications	Table 5.1, Page 503 & 504	Table 5.1, Page 503
LED Wavelengths	Figure 5.9, Page 504	Figure 5.9, Page 504
LED Applications	Figure 5.10, Page 505	Figure 5.10, Page 505

Photoresistor (light controlled variable resistor)
Visible spectrum - cadmium sulfide
IR spectrum - lead sulfide
Incoming photons disrupt crystalline structure and free up electrons which increases current flow
"Dark" Mega Ohms
"Light" 300 Ohms
Circuits require DC voltage source
Time delays (wavelength dependent)
milliseconds reaction time to incoming energy
seconds delay to return to dark state
Examples: light meter, light sensitive voltage divider

Photodiode (generate current - very linear wrt light intensity / current)
"Photo-Voltaic" (current source)
"Photo-Conductive" (similar to photoresistors)
Small surface area provide fast response - good for detecting pulses of energy
Large area, more current, slower response times

Solar Cells - large capacity photodiodes (typical values 0.5 V @ 0.1 A)
Connected in series - increases voltage
Connected in parallel - increases current

Phototransistor - light sensitive gates which can be used to control current flow

Thyristor - fast acting electronic switches (four layered PNPN diodes with 2 to 4 leads)

2 lead - forward conducting (specified DC voltage)

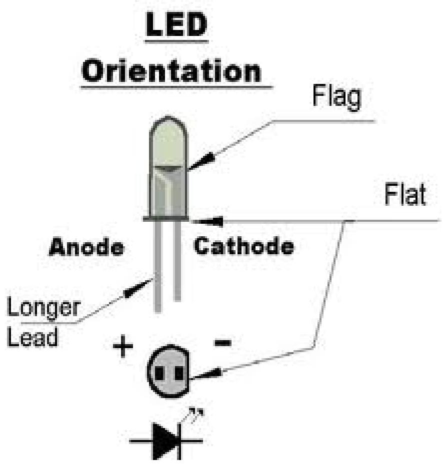
2 lead - **DIAC** Diode for Alternating Current

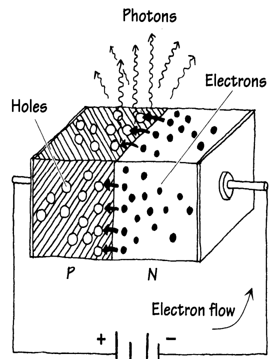
3 lead - **SCR** Silicon Controlled Rectifier
requires only very small gate current to turn on
after being tripped, remains turned on

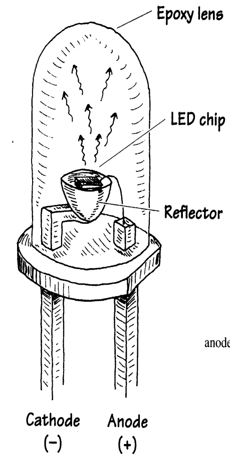
3 lead - **TRIAC** Triode for Alternating Current
current flows in both directions when gate voltage is exceeded

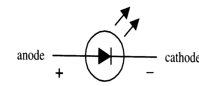
4 lead - **SCS** Silicon Controlled Switch
turned off by applying positive voltage to anode gate

Light Emitting Diode LED

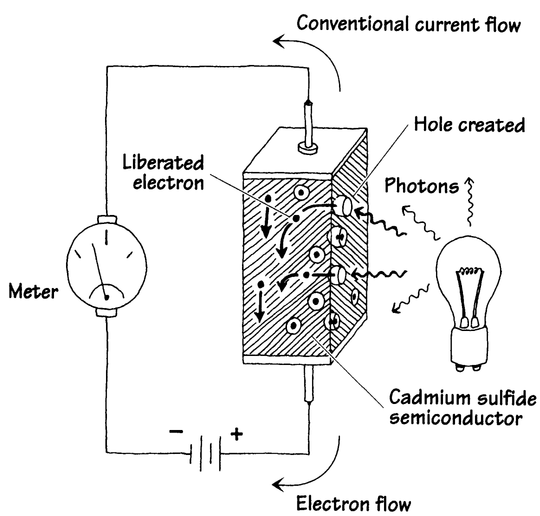


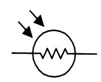


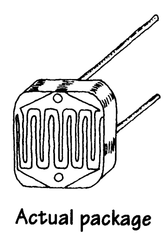




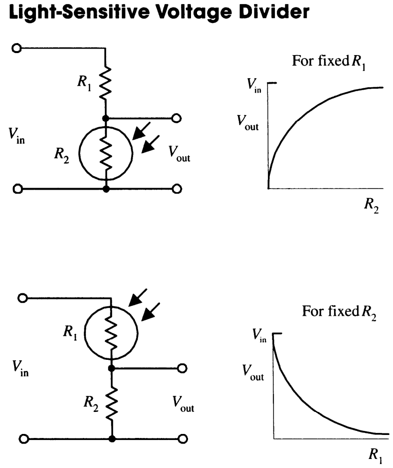
PhotoResistor







Light-Sensitive Voltage Divider

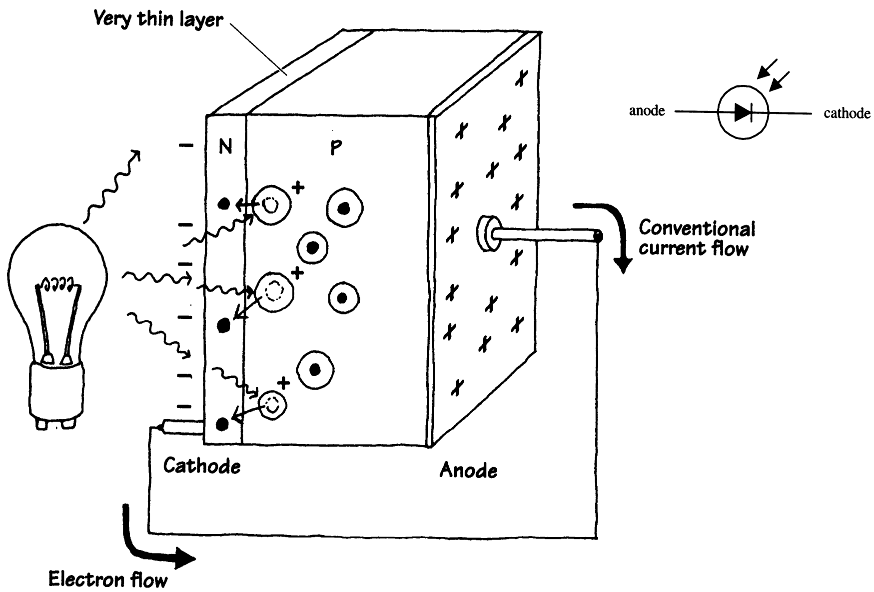


$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

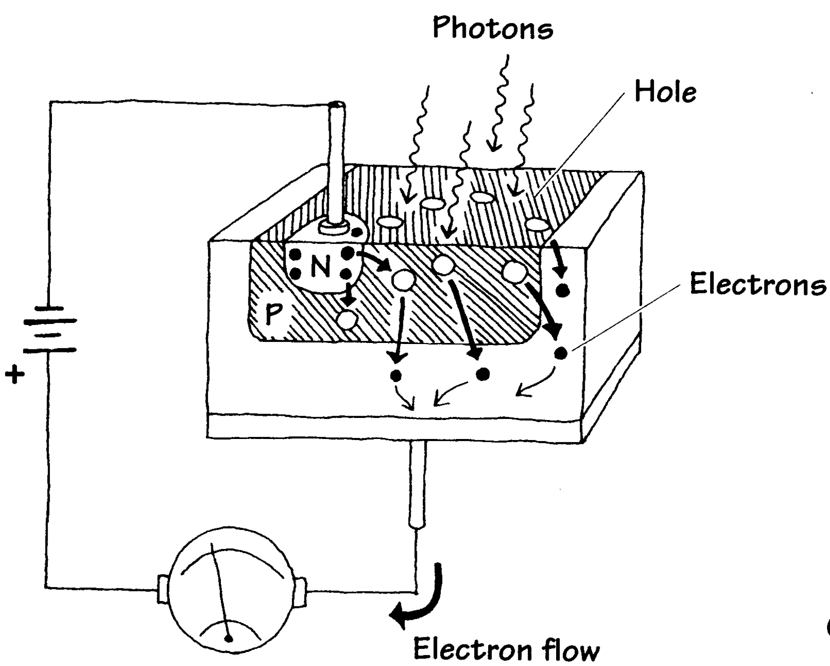
As the intensity of light increases, the resistance of the photoresistor decreases, so V_{out} in the top circuit gets smaller as more light hits it, whereas V_{out} in the lower circuit gets larger.

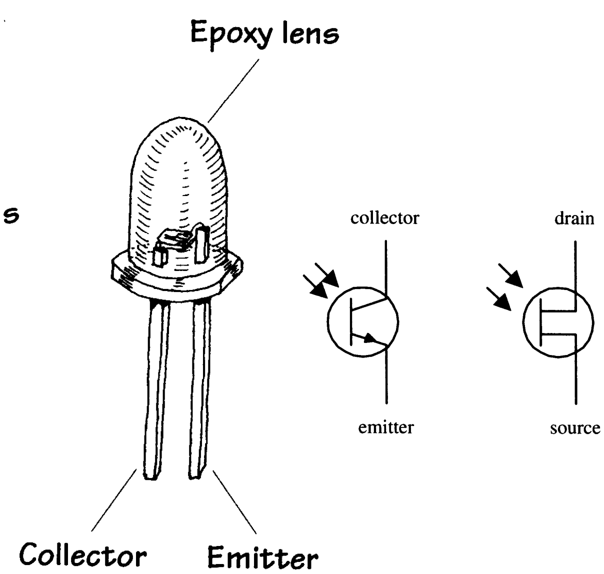
Scherz, Practical Electronics for Inventors, 2nd & 3rd Editions

PhotoDiode



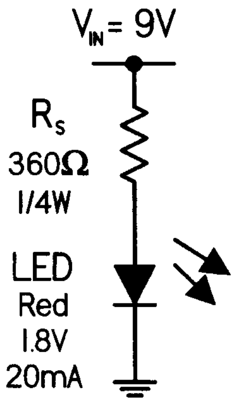
PhotoTransistors





Source: Scherz, Practical Electronics for Inventors, 2nd & 3rd Editions

LED Current Limiting

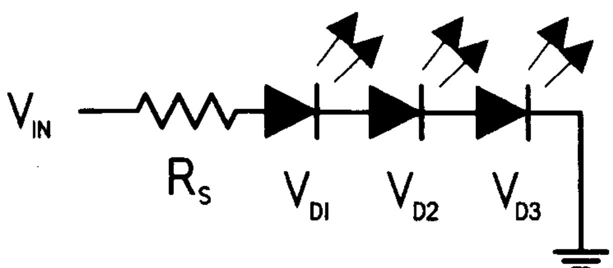


$$R_S = \frac{V_{IN} - V_{LED}}{I_{LED}}$$

V_{LED} = LED forward voltage

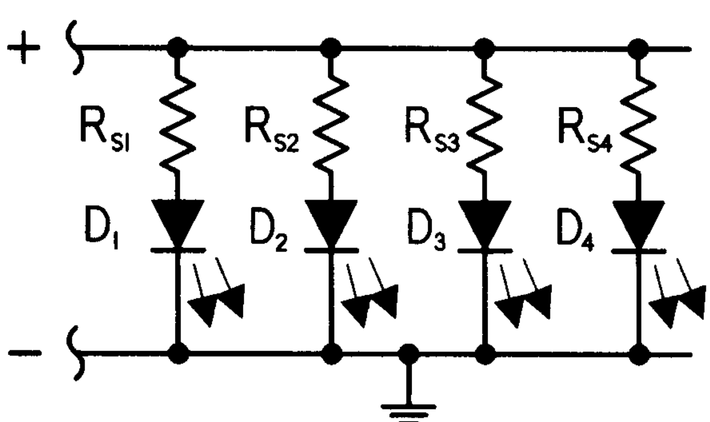
I_{LED} = LED forward current

LEDs in Series



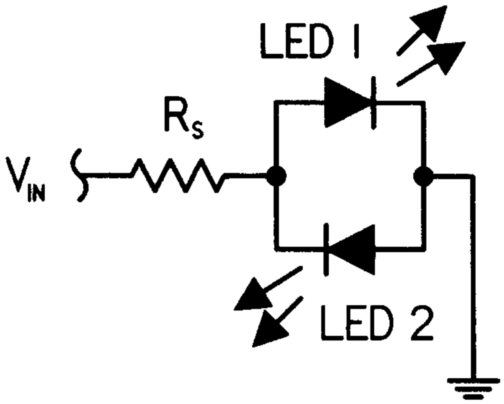
$$R_S = \frac{V_{IN} - (V_{D1} + V_{D2} + V_{D3})}{I_{D,\max}}$$

LEDs in Parallel



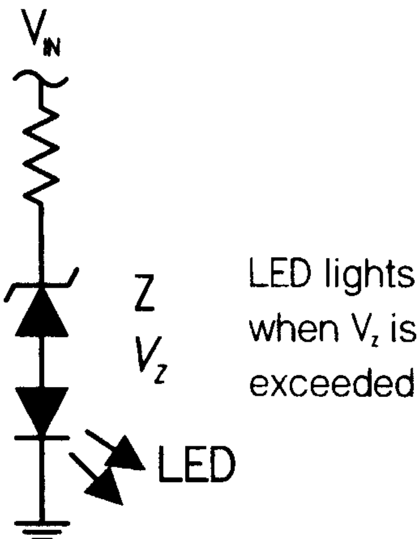
Reference: Scherz, Practical Electronics for Inventors, 2nd & 3rd Editions

AC-DC Polarity Indicator



V_{IN}	LED 1	LED 2
+	On	Off
−	Off	On
AC	On	On

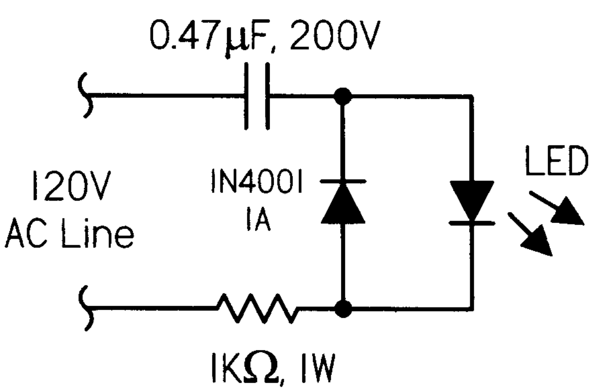
Voltage-Level Indicator



$$R_S = \frac{V_{In} - [V_Z + V_{LED}]}{I_{LED}}$$

$$V_{In(Minimum)} = R_S I_{LED} + V_Z + V_{LED}$$

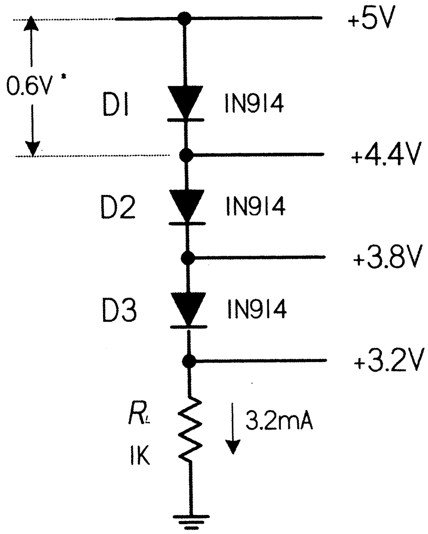
Driving LEDs from 120VAC



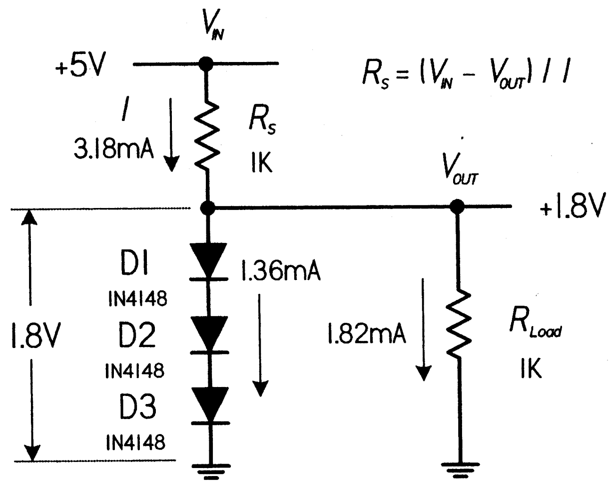
Reference: Scherz, Practical Electronics for Inventors, 2nd & 3rd Editions

Voltage Dropper

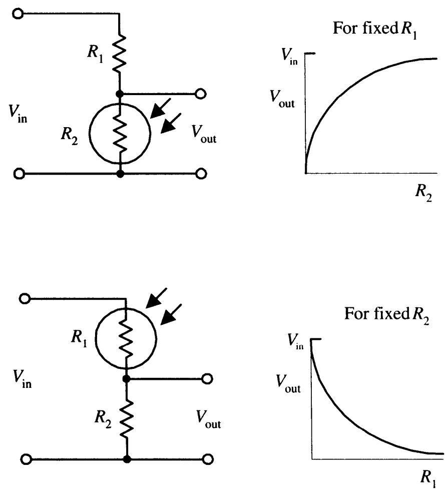
DC application



Voltage Regulator



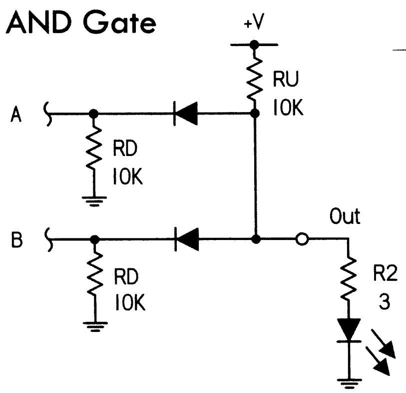
Light-Sensitive Voltage Divider



$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

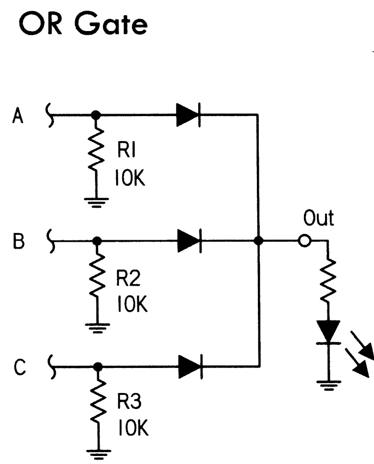
As the intensity of light increases, the resistance of the photoresistor decreases, so V_{out} in the top circuit gets smaller as more light hits it, whereas V_{out} in the lower circuit gets larger.

Diode Logic Gates



A	B	LED
0	0	OFF
0	0	OFF
0	1	OFF
0	1	OFF
1	0	OFF
1	0	OFF
1	1	OFF
1	1	ON

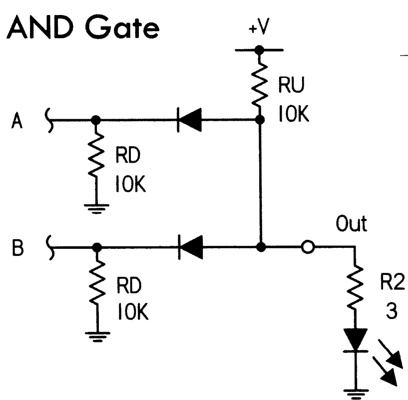
0 = LOW = GND
1 = HIGH = +9V



A	B	LED
0	0	OFF
0	0	ON
0	1	ON
0	1	ON
1	0	ON
1	0	ON
1	1	ON
1	1	ON

0 = LOW = GND
1 = HIGH = +9V

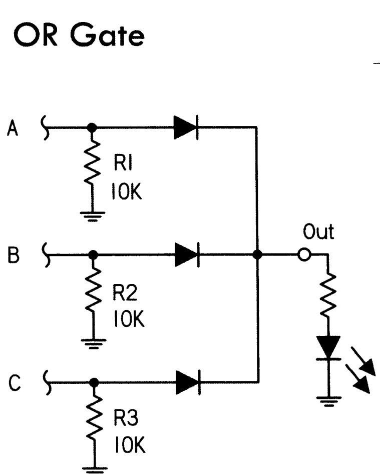
Diode Logic Gates



A	B	LED
0	0	OFF
0	0	OFF
0	1	OFF
0	1	OFF
1	0	OFF
1	0	OFF
1	1	OFF
1	1	ON

0 = LOW = GND
1 = HIGH = +9V

Diode Logic Gates



A	B	LED
0	0	OFF
0	0	ON
0	1	ON
0	1	ON
1	0	ON
1	0	ON
1	1	ON
1	1	ON

0 = LOW = GND
1 = HIGH = +9V

Scherz, Practical Electronics for Inventors, 2nd & 3rd Editions