Optocouplers

Peculiar Parts, the series

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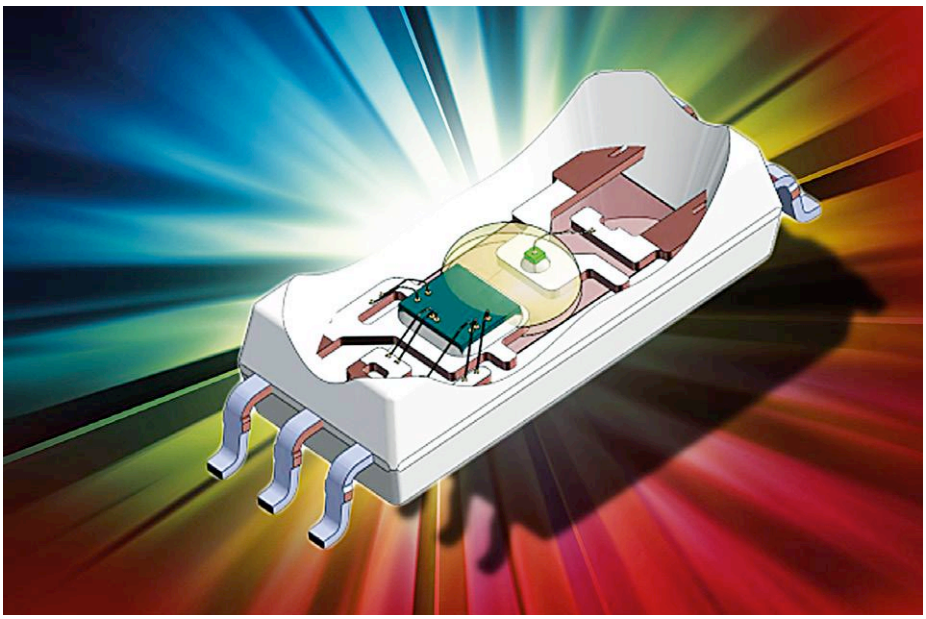

Sometimes circuits need to be isolated from each other for safety reasons, noise reduction or even to simplify a circuit function. An early classic example is the photoresistor that Gibson and Fender used to add a tremolo effect in early guitar amplifiers. This photoresistor was an early form of an optical coupler (optocoupler) that varied the resistance of a cadmium sulphide (CdS) cell using a light source to modulate the amplifier bias to create the tremolo effect. They were simple to make from discrete components and eventually companies like VacTec integrated them into a single component in the 1960's.

In general an optocoupler uses light to connect a circuit across an isolation gap instead of a straight electrical connection. The isolation gap allows the circuit to withstand very high voltages (kV), surges and noise that would normally destroy sensitive electronic components. But isolating a circuit isn't very useful without being able to send a signal across the isolation gap so an optocoupler also includes a light source and detector on opposite sides of the gap like in **Figure 1**. This arrangement works well for signals but is impractical for transmitting power like an isolation transformer. The isolation gap also means that both sides of the circuit will always be isolated even if the optocoupler fails making them suitable as protection devices.

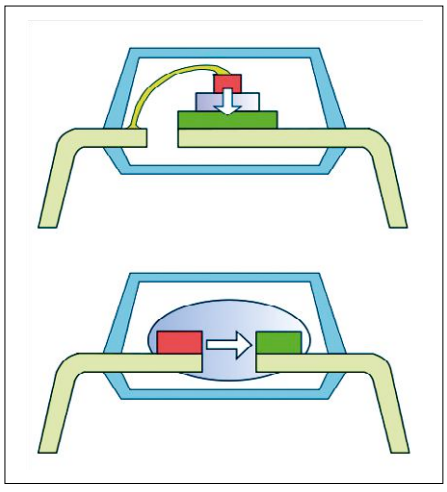

Figure 1. Optocoupler construction [1]

The amount of gap between the light source and the receiver defines the isolation voltage rating with a larger gap increasing the isolation voltage. Devices that only need a few kV of isolation will typically use a planar construction like the top device in Figure 1. The bottom device shows a silicone dome construction where the light shines horizontally to allow for the larger gaps necessary for higher voltage ratings.

Optocouplers originally used incandescent or neon lamps as a light source but that quickly changed in the 1970's when LEDs became available. The LEDs are a vast improvement over lamps because they are more linear, faster and have fewer temperature effects. The detectors have also changed over time from CdS cells to photodiodes and phototransistors. Photodiodes are used for high speed logic interfaces and phototransistors are slower and output a current based on the LED current.

A photoresistor is an example of a linear optocoupler because varying the light bulb (transmitter) current has a corresponding equal change to the CdS cell (receiver) resistance. Digital optocouplers on the other hand are meant to transmit digital on/off signals and are therefore optimized for speed. In fact, some optocouplers like the HP 6N137/HPCL2601 family even contain extra circuitry to drive their LED to increase their operating speed even further.

Optocouplers have been used for a long time and continue to be useful today, although magnetic and capacitive coupled isolators are also now available. Hopefully this has given you some insight into these humble parts. ⏮

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Web Link

[1] https://upload.wikimedia.org/wikipedia/commons/thumb/1/10/Optoisolator_topologies_both.svg/220px-Optoisolator_topologies_both.svg.png