

Electronics

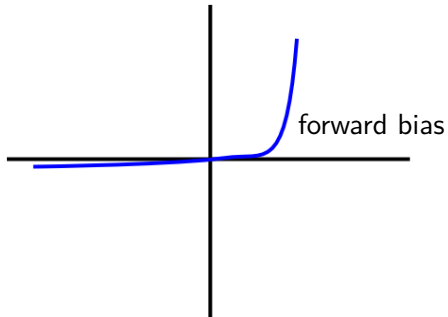
Zener Diodes and Photodiodes

Terry Sturtevant

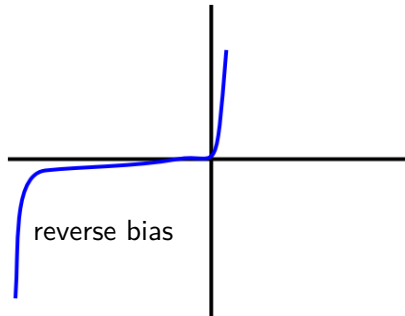
Wilfrid Laurier University

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Basic Diode Operation



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- The diode will not conduct when it is *reverse biased* until the input voltage goes above about the *reverse breakdown voltage*, which is typically large.

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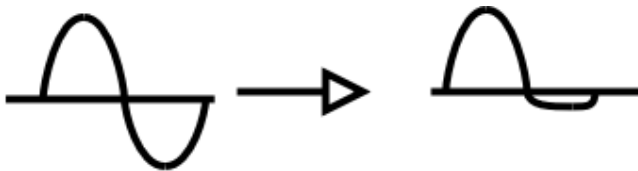
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- For instance, a sensor inside the engine of a car may pick up electrical noise. A negative voltage due to noise could destroy a microprocessor.

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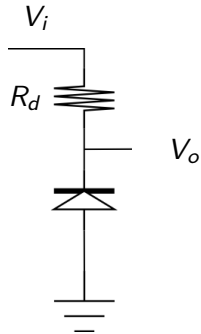
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- For instance, a sensor inside the engine of a car may pick up electrical noise. A negative voltage due to noise could destroy a microprocessor.
- To avoid this, the signal may be **clamped** so that it never goes below zero.
- This can be done using a diode.



Clamping a signal



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- The resistor should be chosen so that the maximum current through the diode is within the specified limits.

Zener diodes

Zener diodes

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Zener diodes

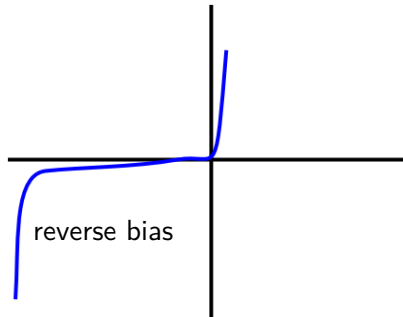
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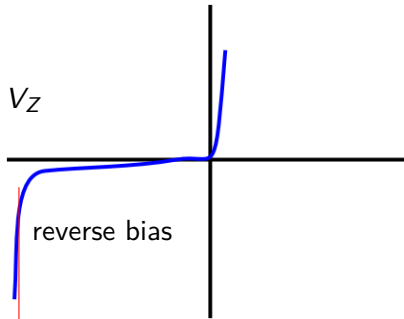
Zener diodes

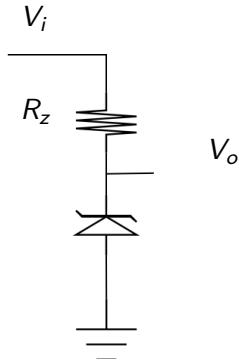
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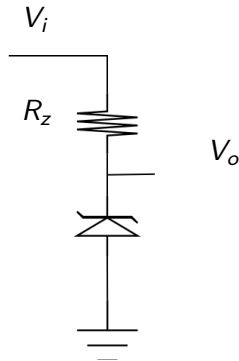
Zener diodes

- The Zener diode will conduct in reverse bias once the voltage exceeds the Zener voltage, V_Z .
- The output voltage will follow the input until the input exceeds V_Z .
- From then on the output will not increase.
- It is usually placed in a voltage divider with a resistor chosen so that the maximum current through the diode is within the specified limits.

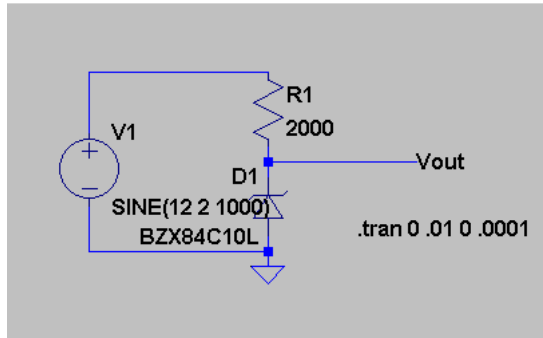


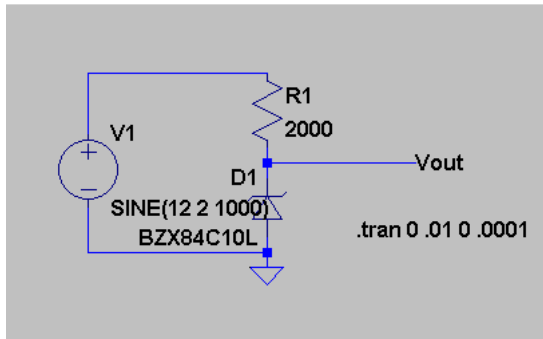




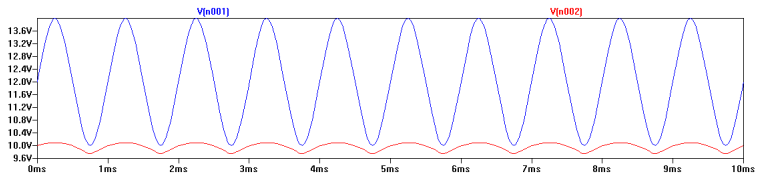


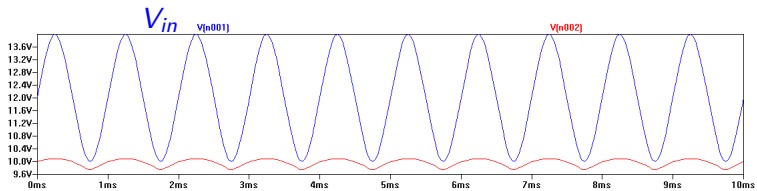
Here's the typical circuit.

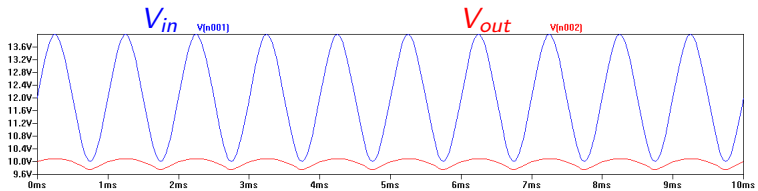


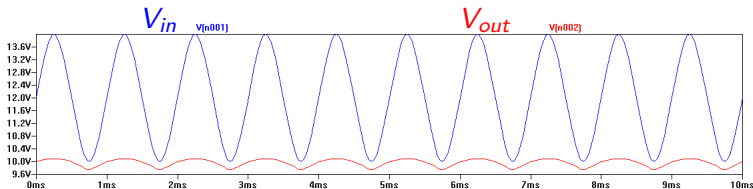


Here's a Zener diode circuit simulation drawing.

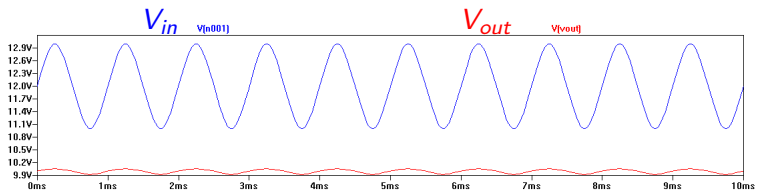


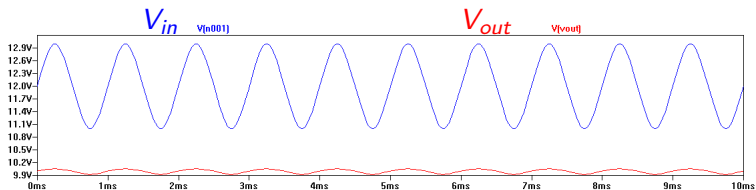






For a 10V Zener diode, the output voltage range is much less than the input range.





The output range is smaller if the input range is smaller.

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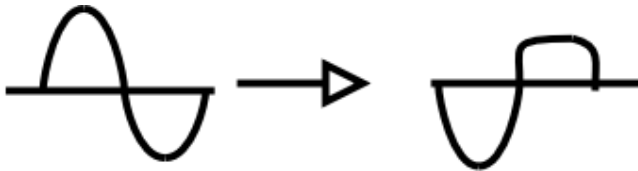
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- To avoid this, the signal may be **clipped** so that it never goes above a fixed voltage.

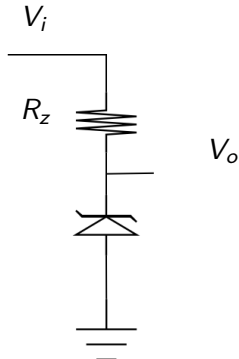
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This can be done using a Zener diode.



Clipping a signal



Calculating Resistance

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$$R = \frac{V_S - V_Z}{I}$$

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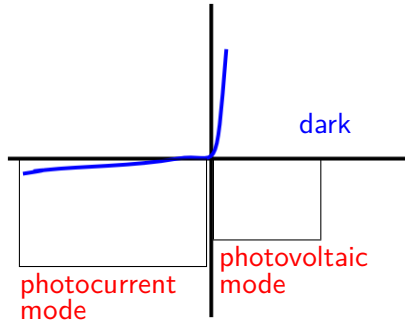
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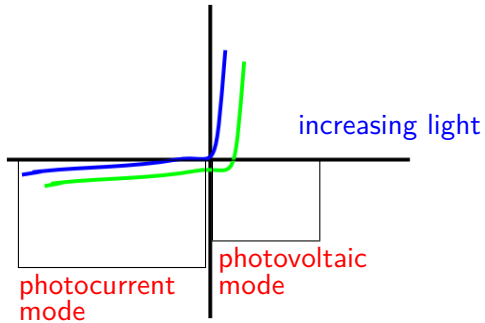
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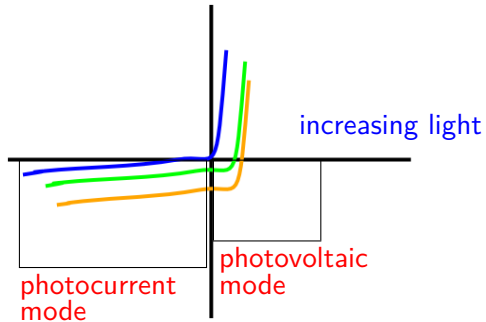
LEDs can also be used as photodiodes.

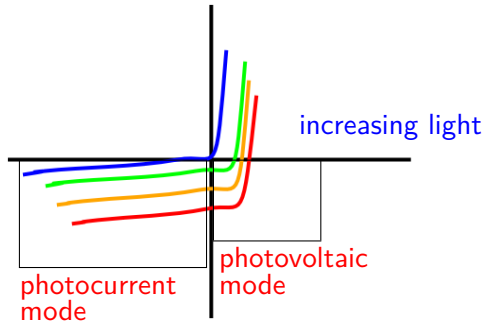


Photodiode symbol









- To use a photodiode in photovoltaic mode:

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- To use a photodiode in photovoltaic mode:
Measure the forward-biased voltage which changes with light
- To use a photodiode in photocurrent mode:
Put it reverse-biased in a voltage divider like a Zener diode
and measure the reverse-biased voltage which changes with
light

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$$R = \frac{V_S - V_o}{I_p}$$

Optical Isolation

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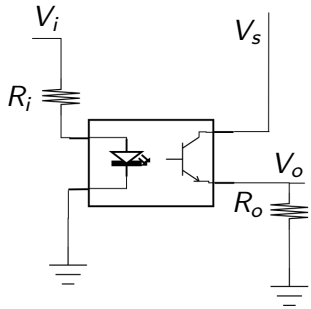
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- the above two conditions mean that there is no danger of voltage spikes as there is with inductive isolation

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- The values chosen for the resistors should be consistent with the current specifications for the device.
- The amount of DC isolation provided by an optoisolator is usually in the range of kV.
- At some point the insulation will break down and arcs can occur.



Whenever sensors are in a place where it is *possible* for high voltages to be induced, optical isolation should be used to protect electronic devices which follow.