Simple Proximity Sensing with Infrared LEDs and Detectors

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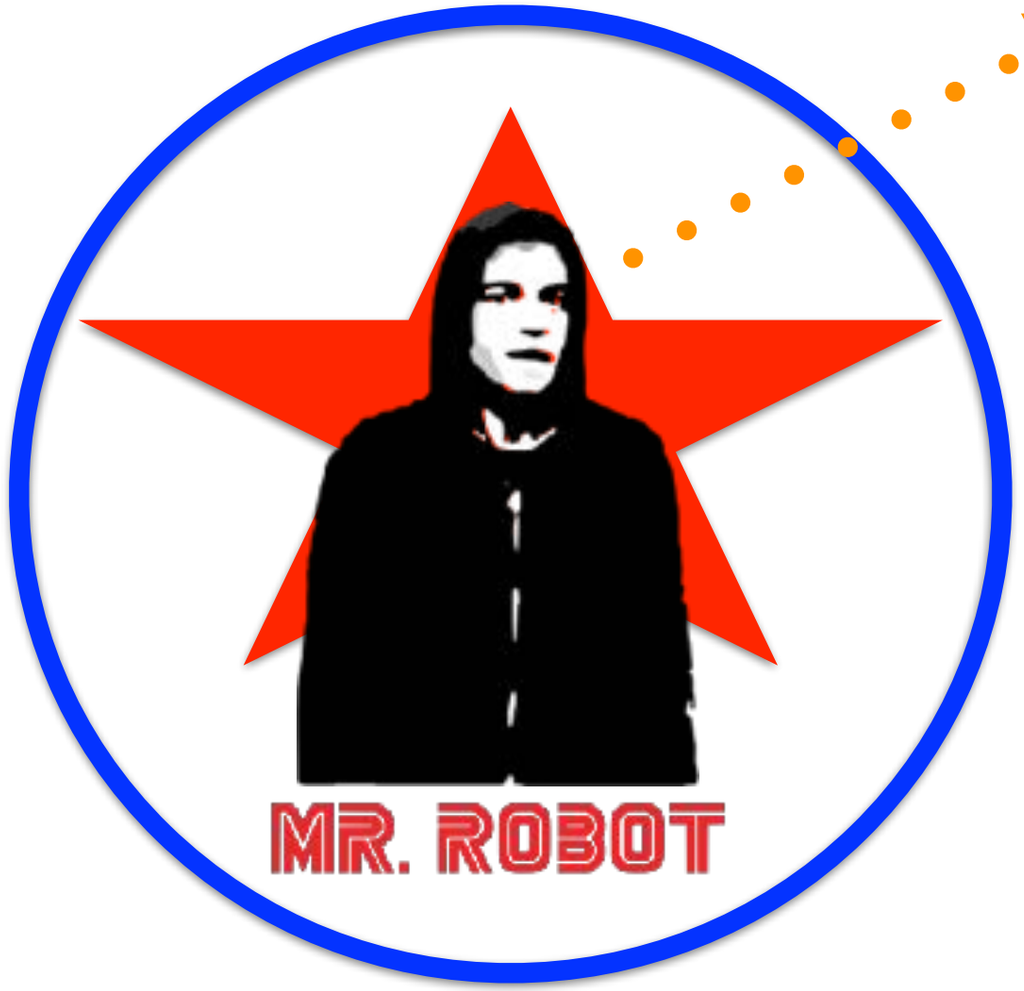
RoboJay.us

Direction and Range

Touch



Proximity

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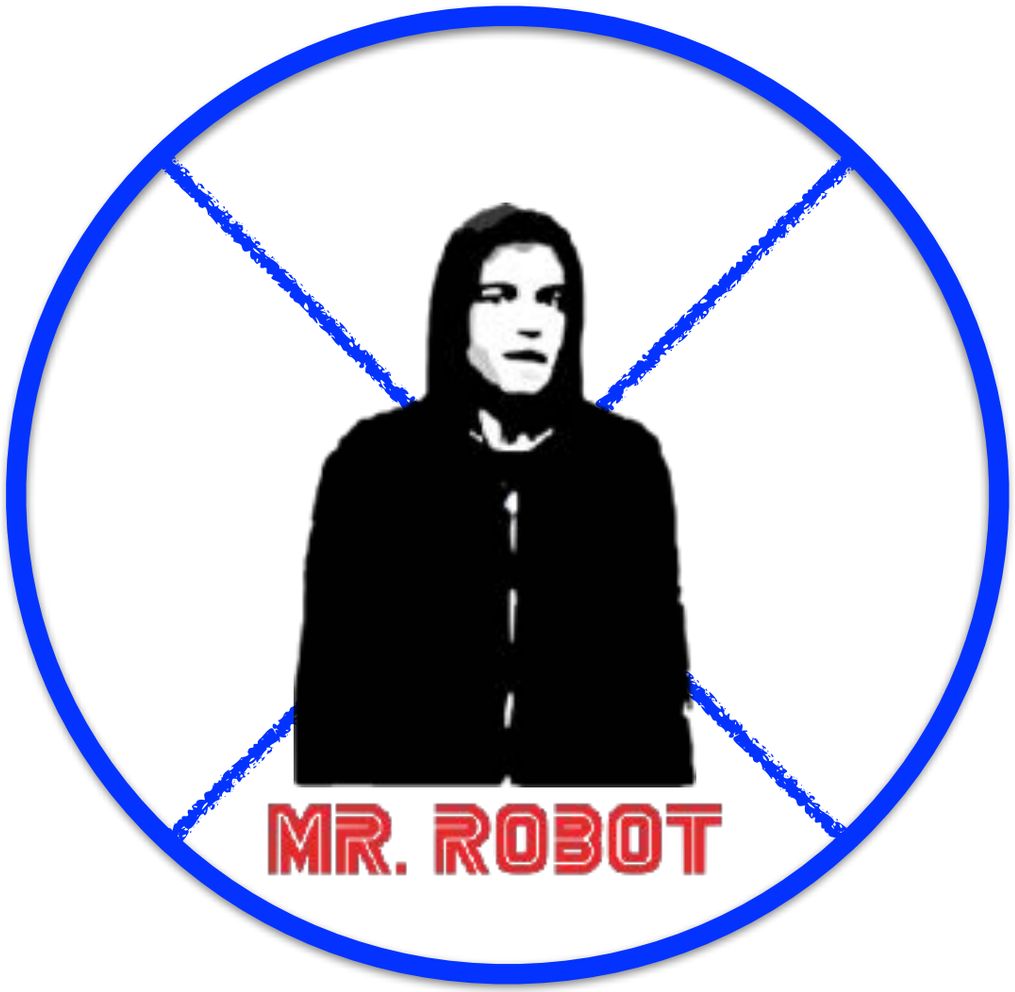
https://commons.wikimedia.org/wiki/File:Mr._Robot_Logo.svg



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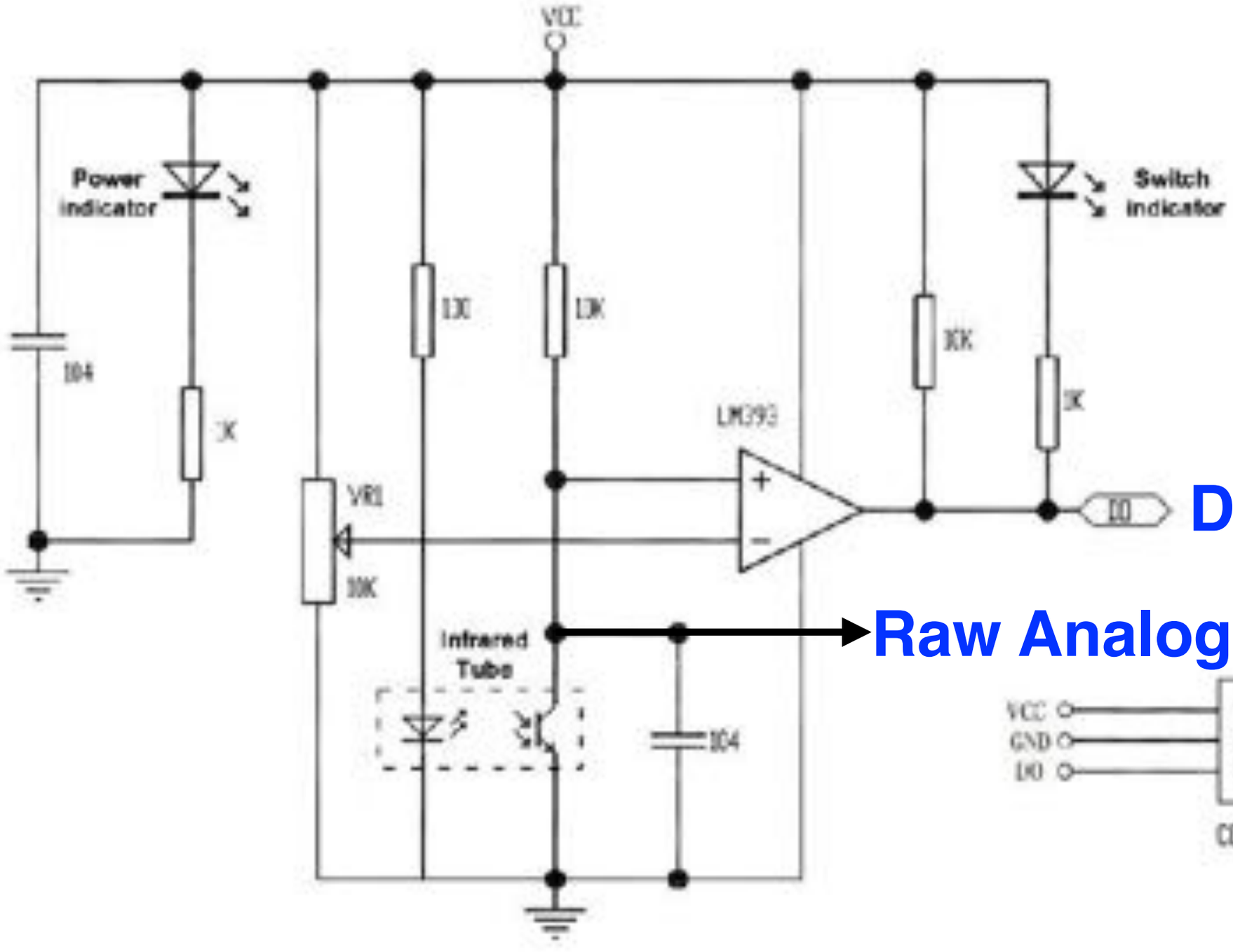
http://www.riorand.com/electronics/circuit-boards/riorand-lm393-voltage-comparator-obstacle-avoidance-infrared-photovoltaic-sensor-module-3-5v-dc.html



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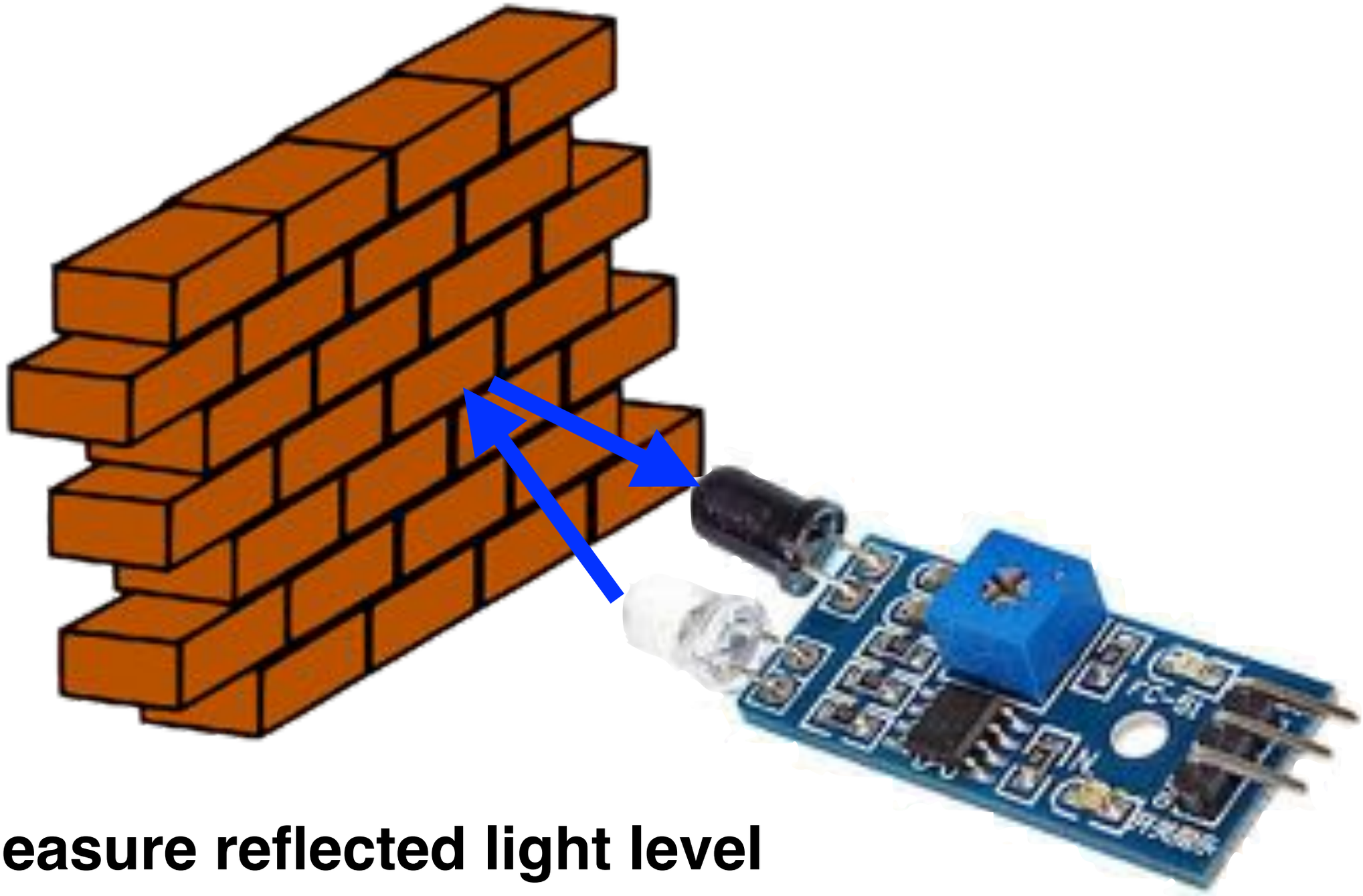

Measure reflected light level to estimate distance

http://www.clipartkid.com/white-face-mess-that-comes-with-the-photos-and-the-dreaded-flash-HJoQe8-clipart/
https://openclipart.org/detail/29265/jersey-wall
https://openclipart.org/detail/170680/weather-icon-sun-rain
https://openclipart.org/detail/169312/red-brick-wall
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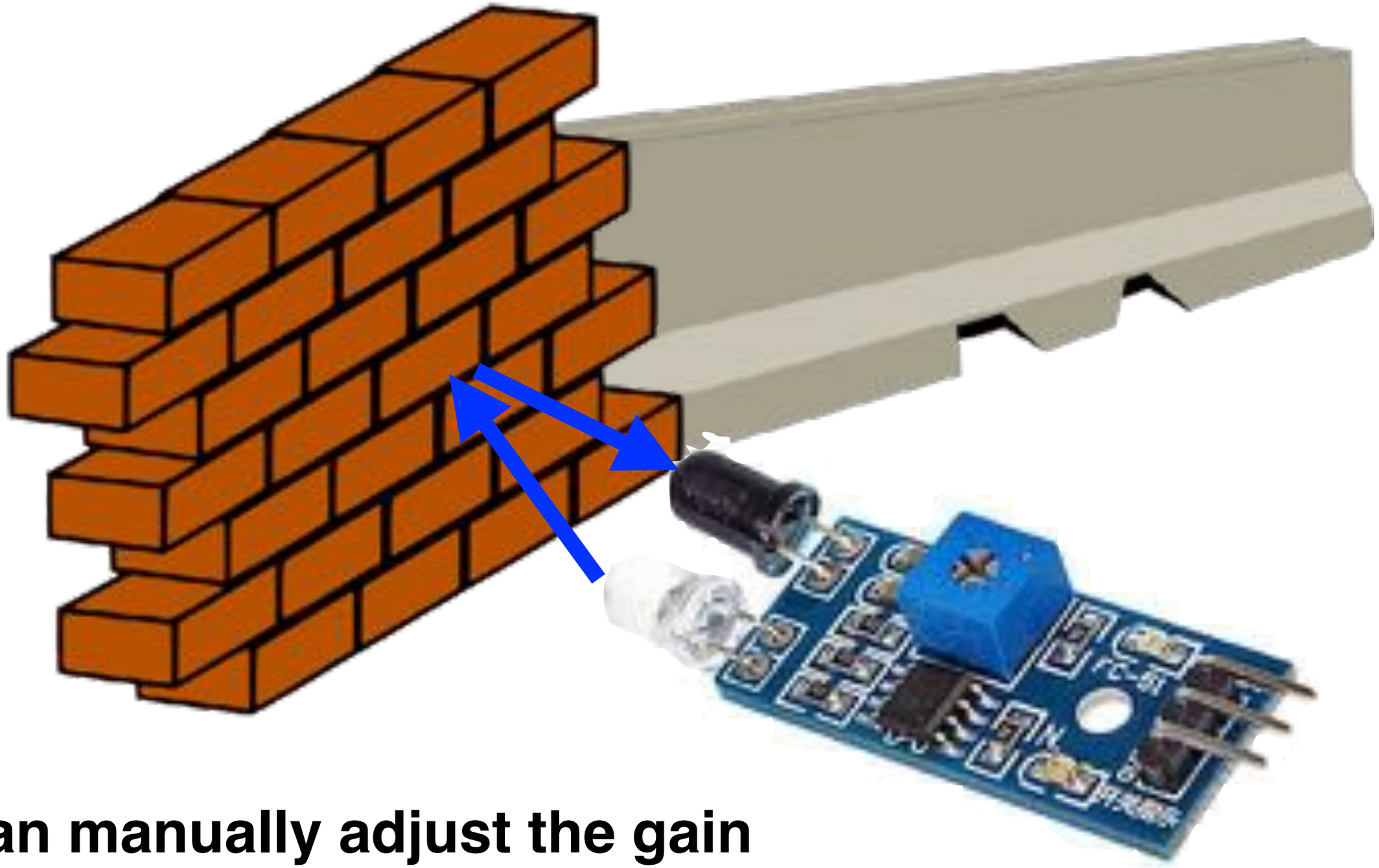

Can manually adjust the gain to find a compromise

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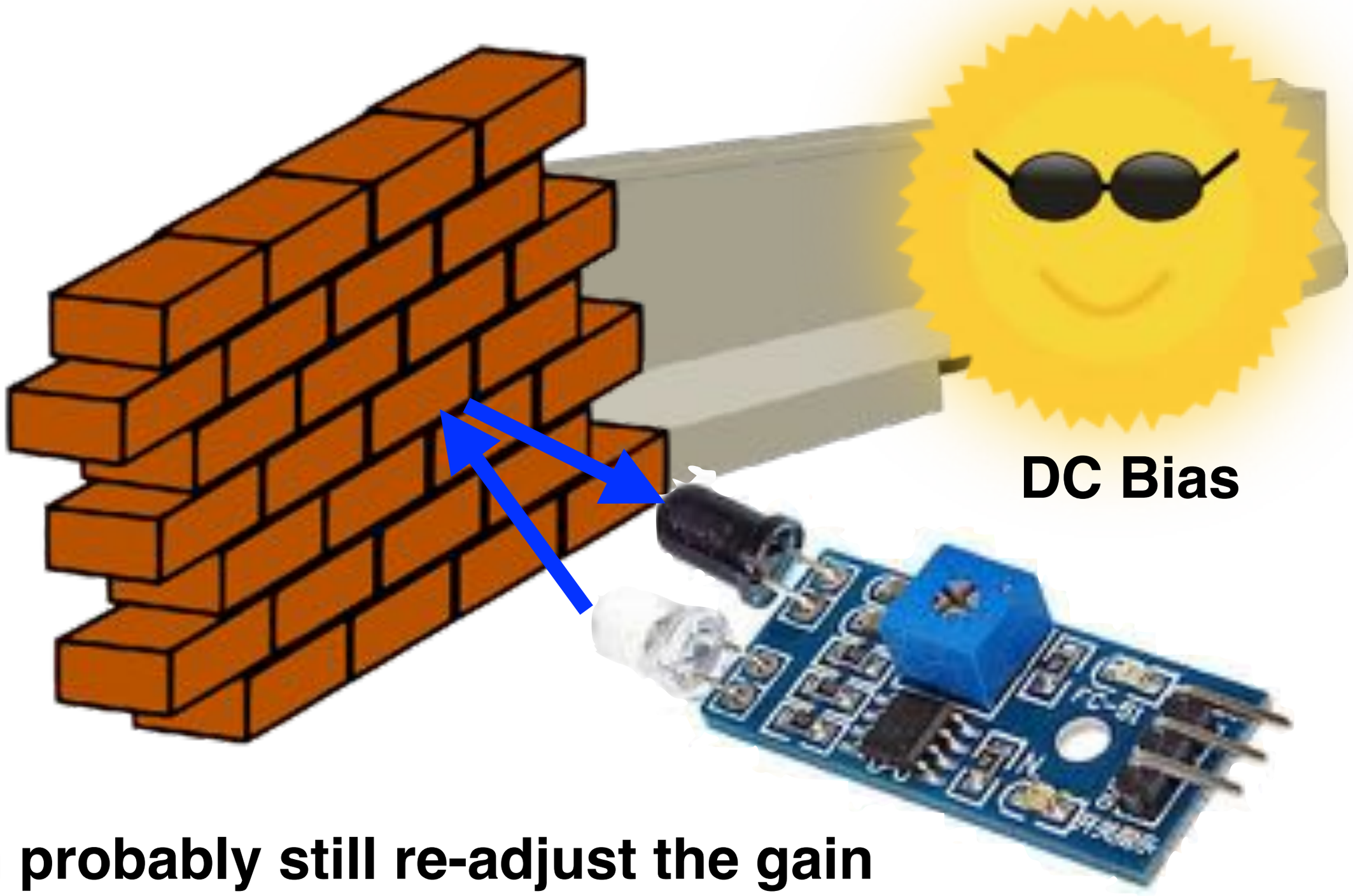

Can probably still re-adjust the gain to find a compromise

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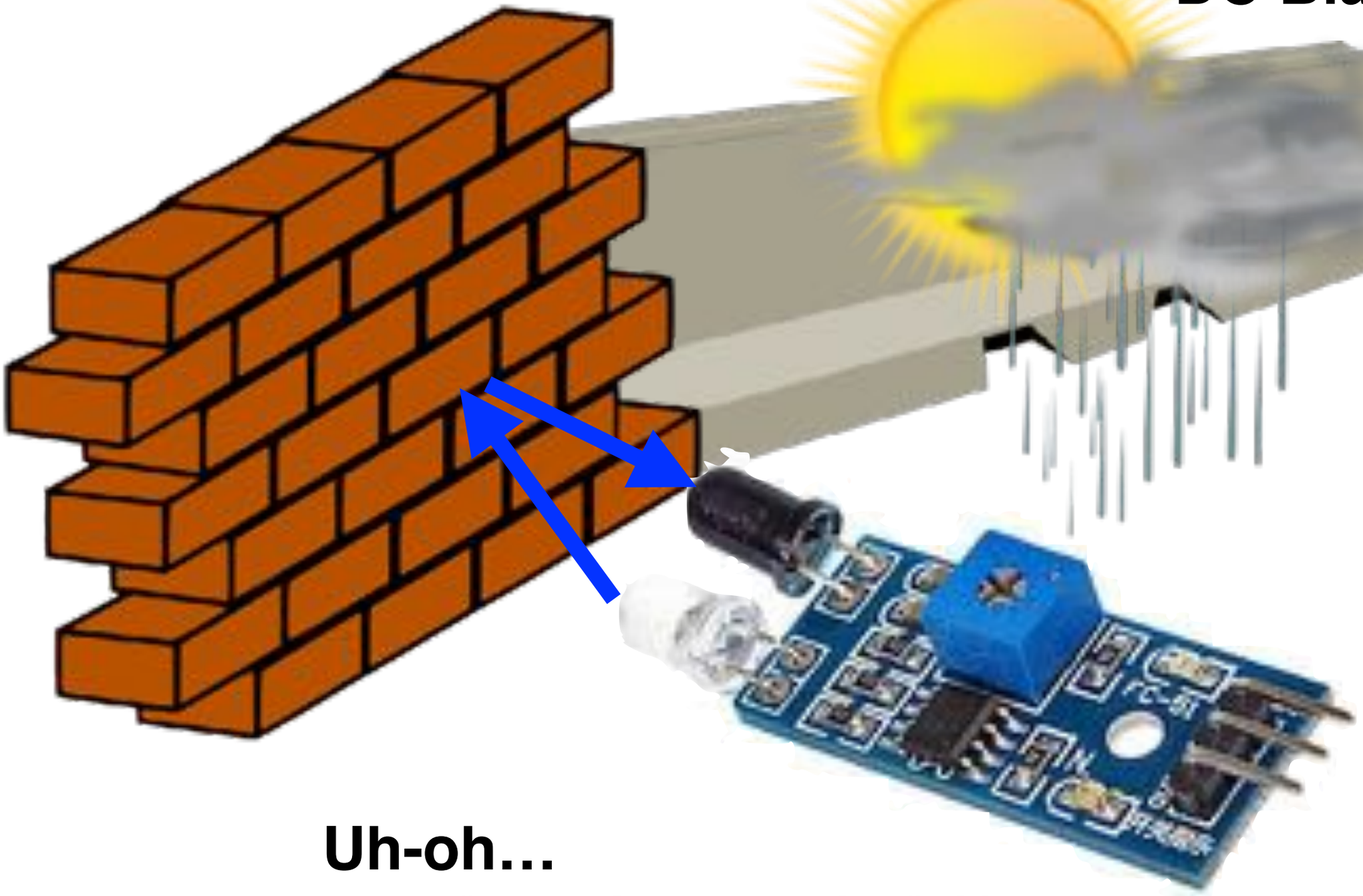
Slowly Changing
DC Bias



Uh-oh…
Time for Automatic Gain Control (AGC)

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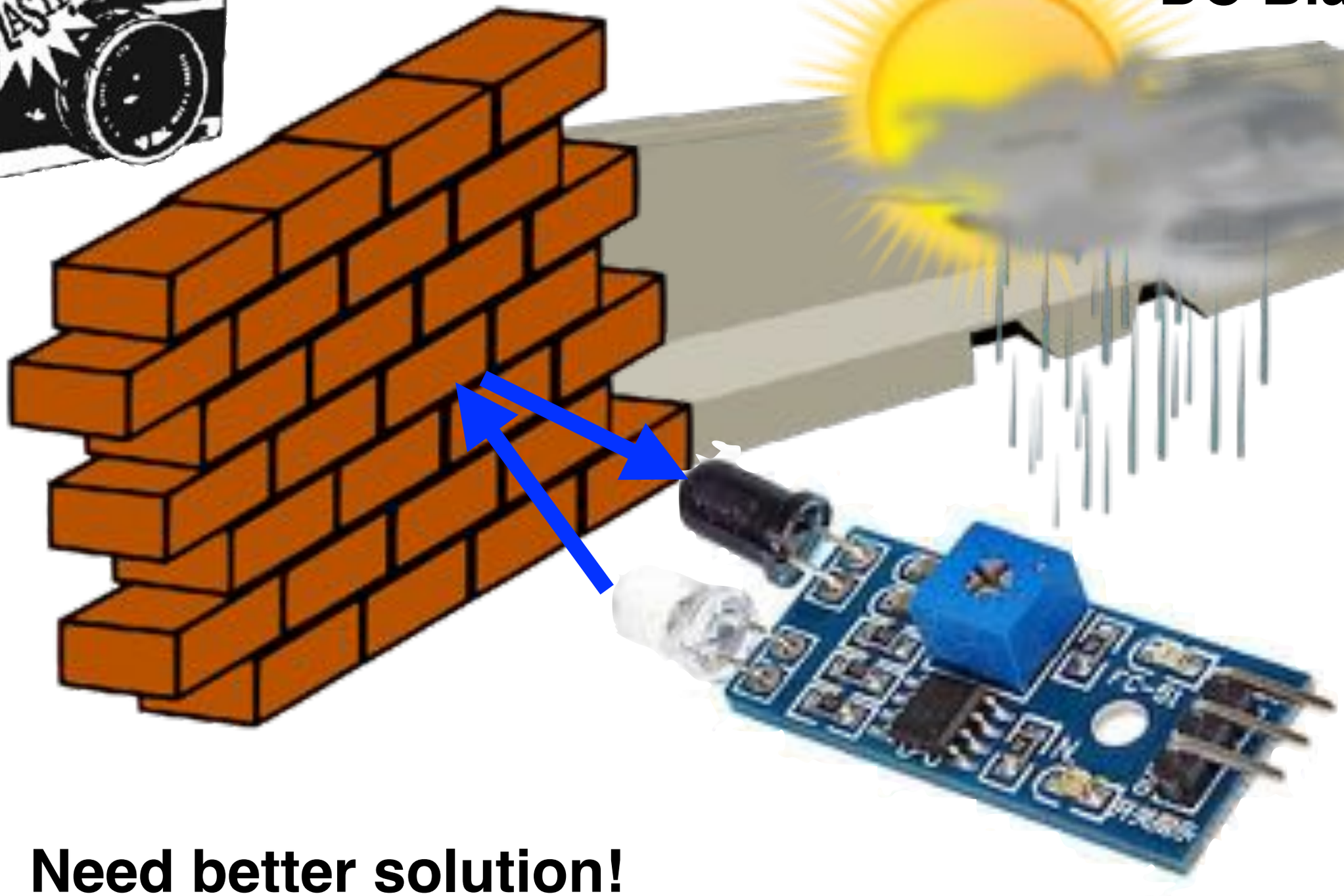
Random Pulses

Slowly Changing DC Bias



Need better solution!

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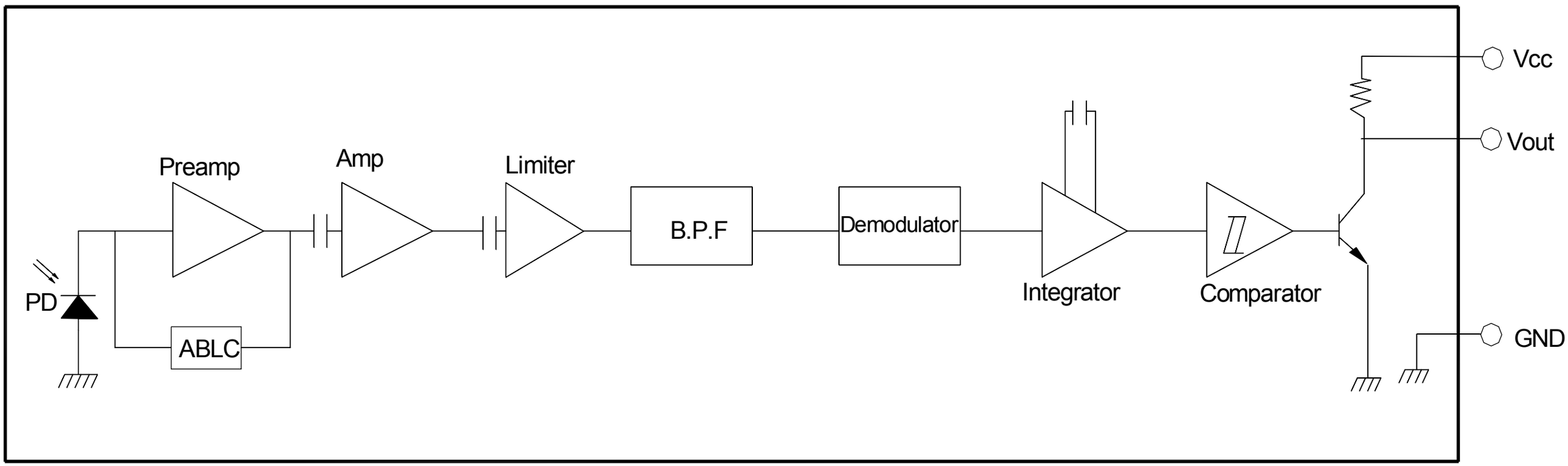
Nice things to have…

- Amplifier with Automatic Gain Control
- Ignore ambient light levels
- Not be fooled by random light

Nice things to have…

- Amplifier with Automatic Gain Control
  Ok - just add it
- Ignore ambient light levels
  Capacitively couple to ignore DC component
- Not be fooled by random light
  Since we're ignoring DC,
  our light source needs to be modulated,
  and if we're smart,
  we can modulate it such that it doesn't look like other light sources!

Typical Infrared Remote Receiver



https://arduino-info.wikispaces.com/file/view/IR-Receiver-AX-1838HS.pdf

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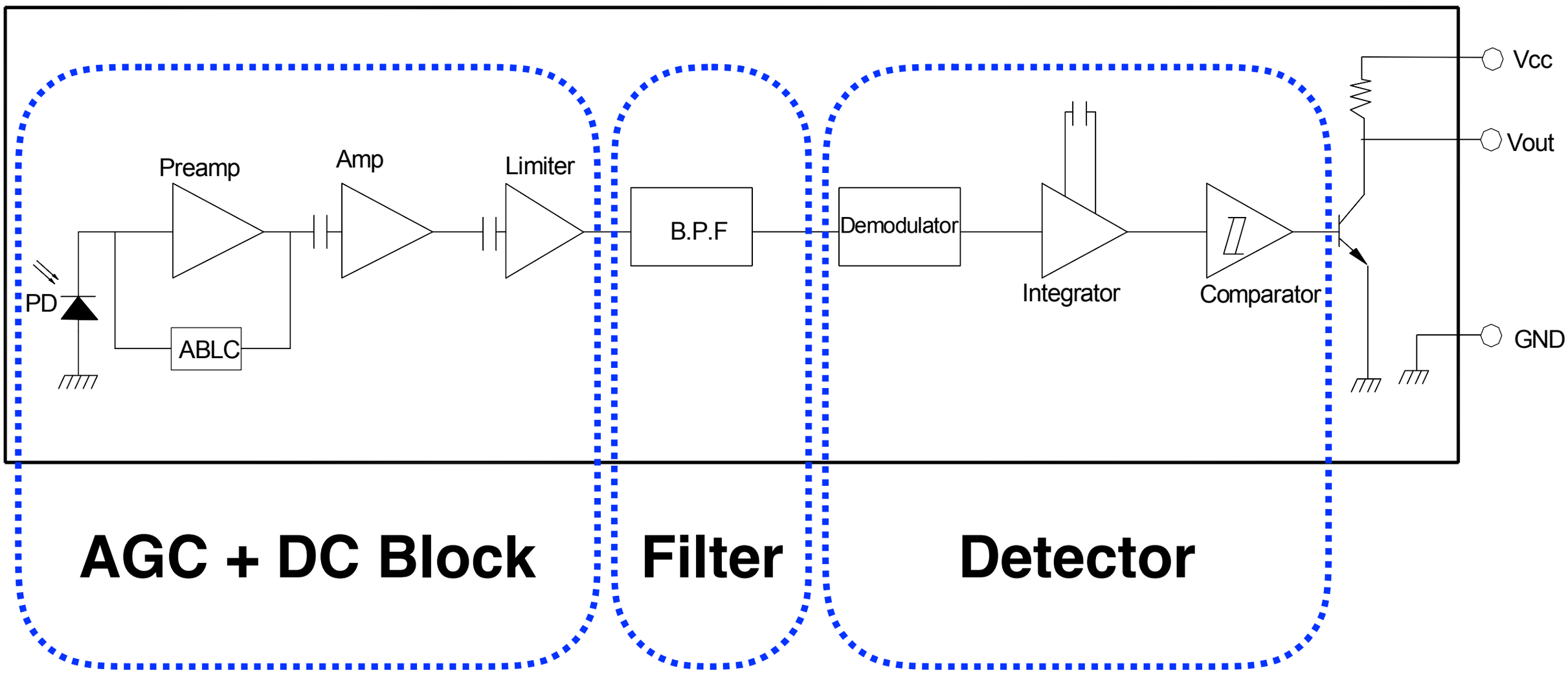

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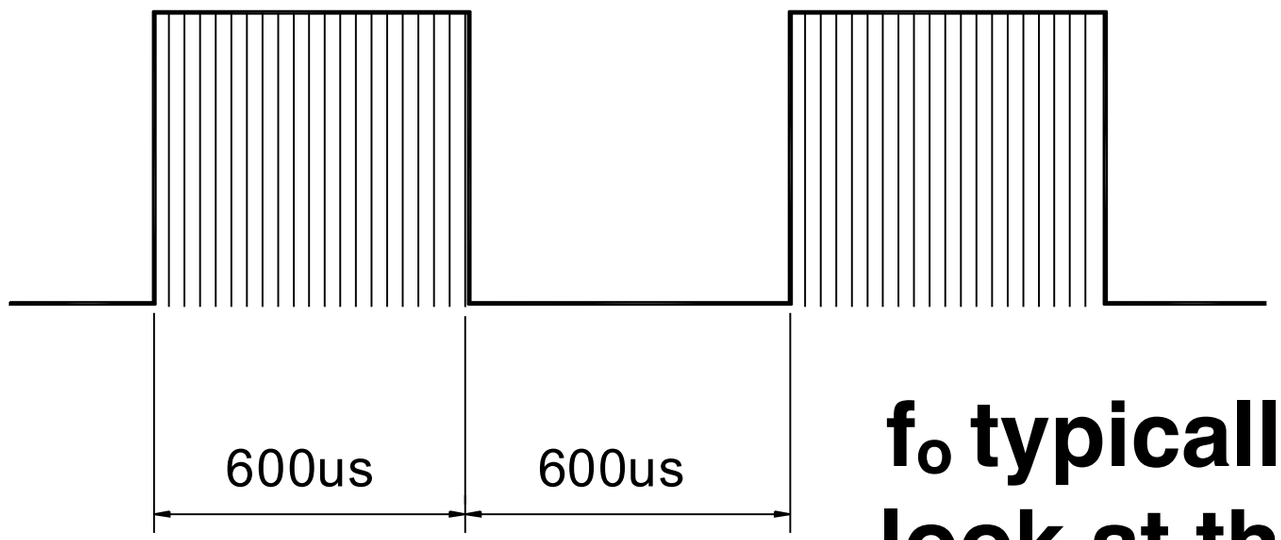
https://buyhere22.com/image/cache/data/products/236/236159/ir-vs1838b-pinout-800x800.png

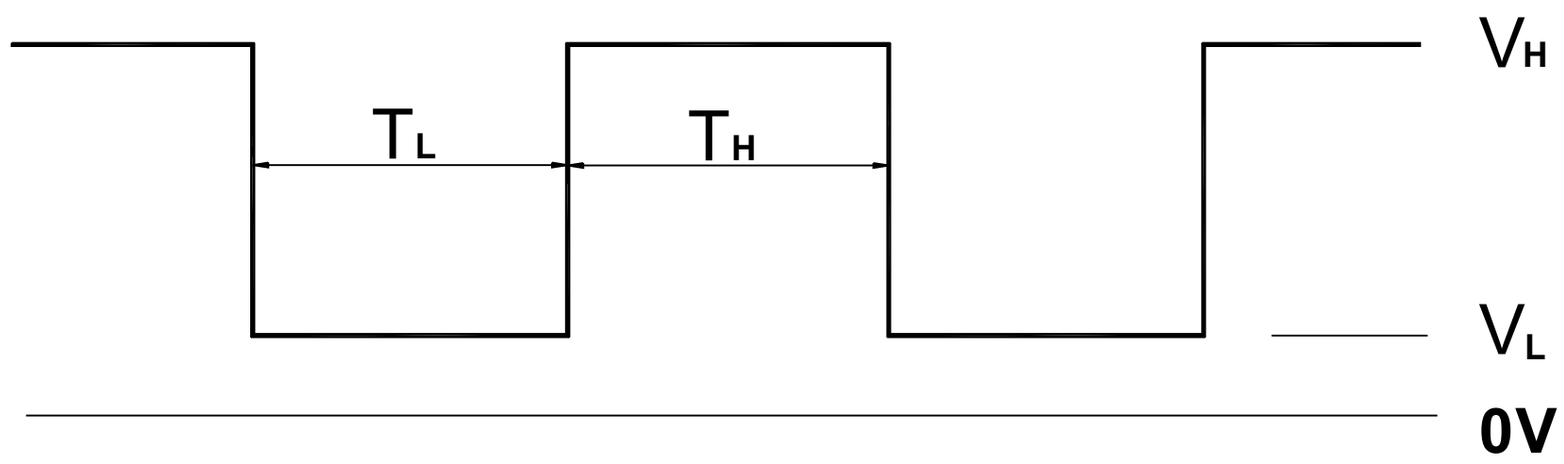
http://www.satistronics.com/images/l/1255/3282.jpg

Transmitter Output



f_o typically 30 - 50 kHz
look at the data sheet!

D.U.T Output Pulse



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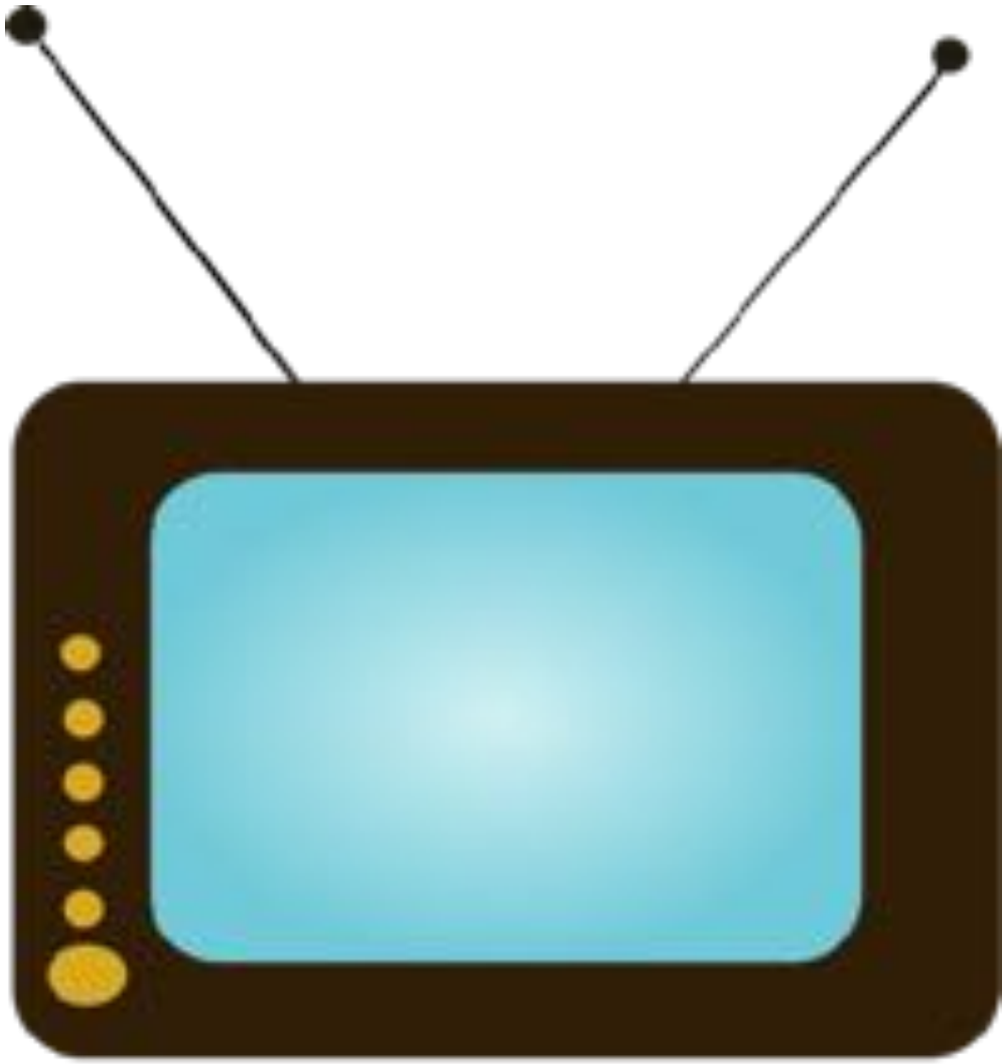
One problem…

Infrared remotes and receivers are designed to operate over large distances…



https://openclipart.org/detail/2428/tv-set-5

On the plus side…

We’re looking for reflected light pulses, which will be of much lower intensity than the typical application.

And of course, there's a hack…

We could adjust the LED brightness to a level that works for our application.

This is what the LEGO Spybots did to identify distances to other robots (most awesome IR hack ever in a product!).

https://images-na.ssl-images-amazon.com/images/I/41YEAVWGMKL.jpg

And of course, there's a hack…

The disadvantage is this does require some analog elements on the transmitter side.

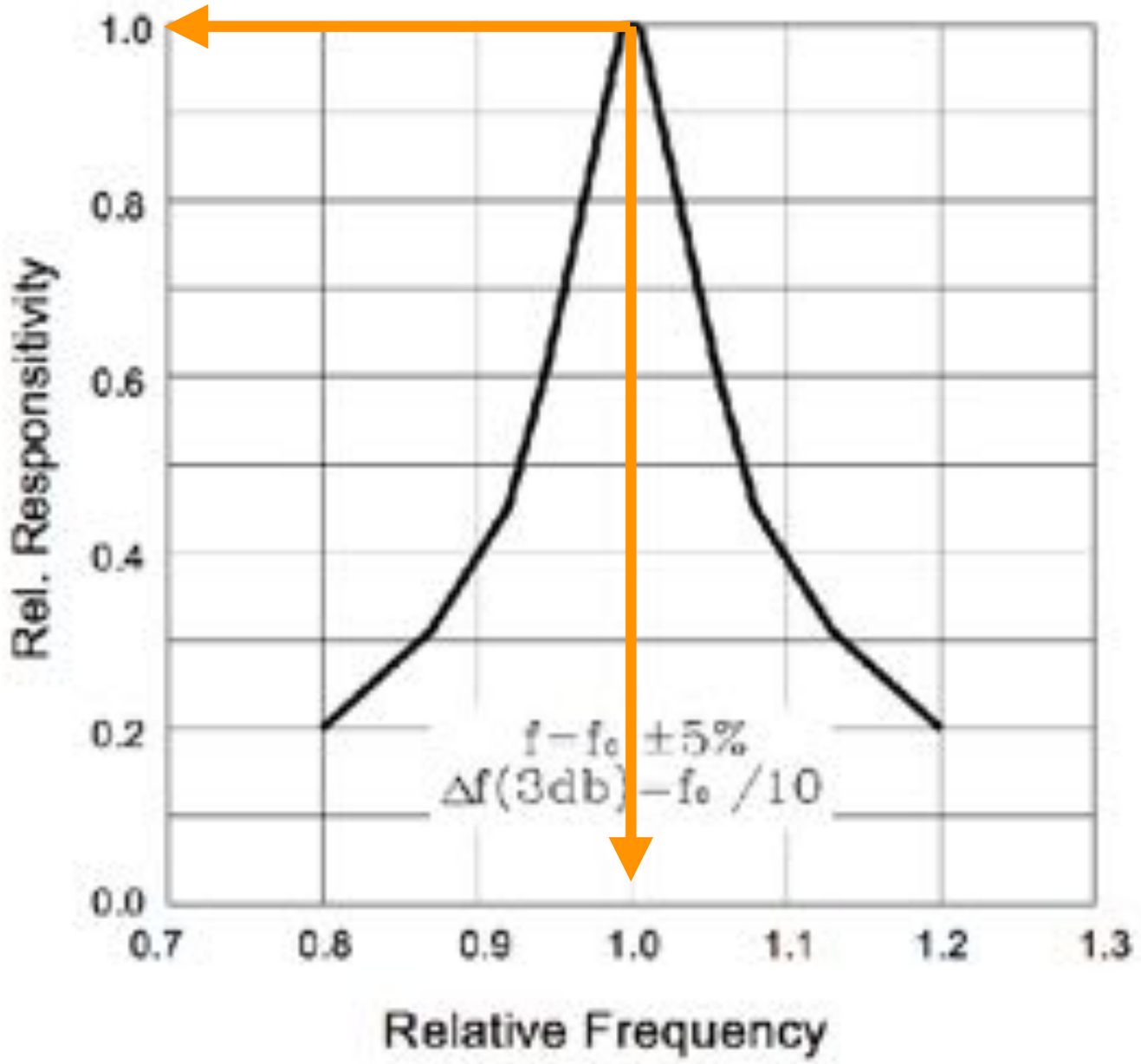
Which leads to a second hack…

And of course, there's a hack…

Adjust the transmit frequency away from the ideal frequency, such that our signal is attenuated by the receiver's filter.

This is easy to do without extra components!

Fig.3 Frequency Dependence of Responsivity



Normally, you want to transmit on the center frequency for best response.

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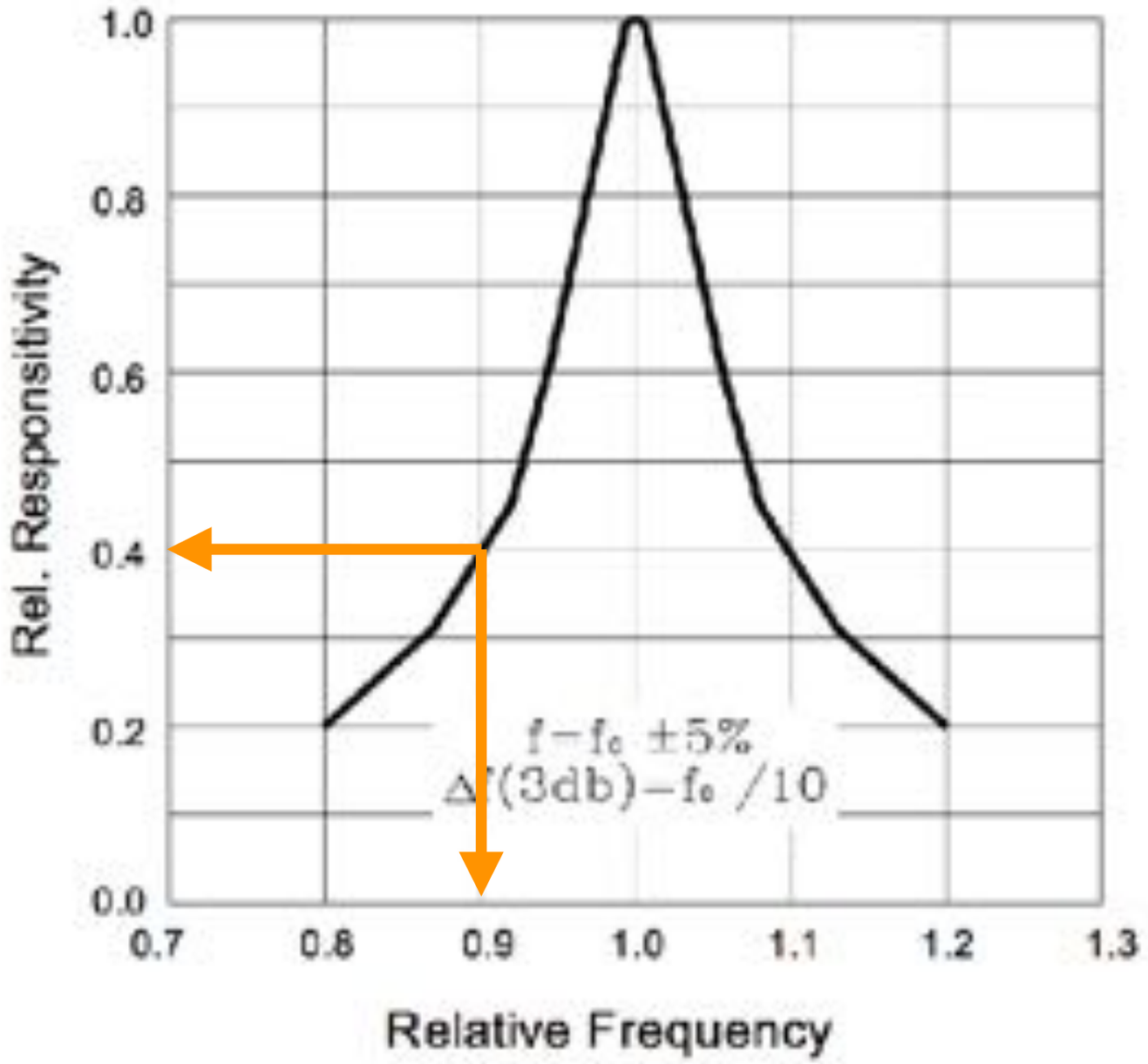
Fig.3 Frequency Dependence of Responsivity



By moving off-center, we can lower the response, which requires a stronger (closer!) reflection.

https://arduino-info.wikispaces.com/file/view/IR-Receiver-AX-1838HS.pdf

Caveats and Fine Points

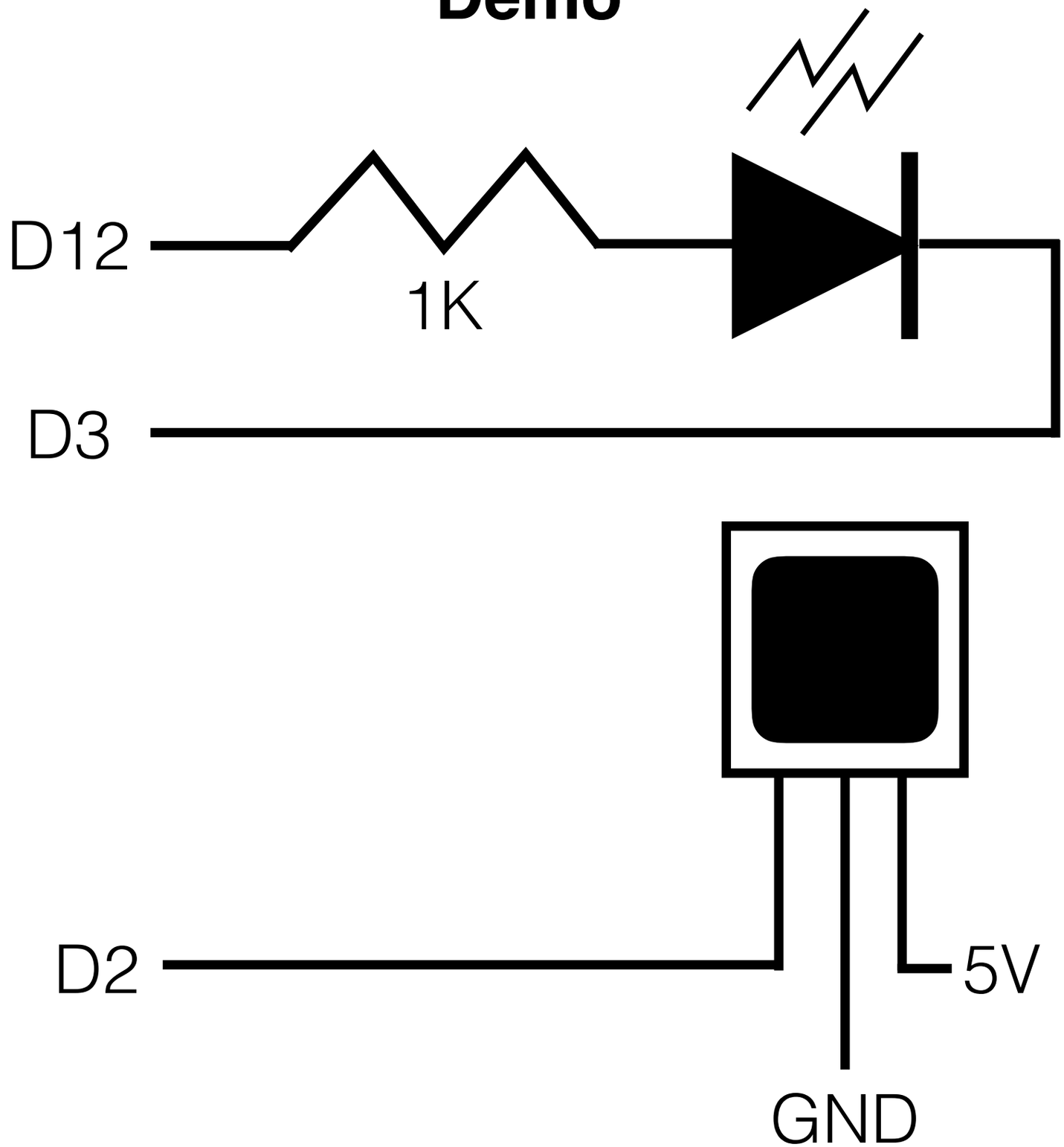
This method will still have different detection distances based on the reflectivity of the object being sensed.

The transmit signal can not be a continuous frequency, it must be pulsed (refer to the data sheet for min/max values).

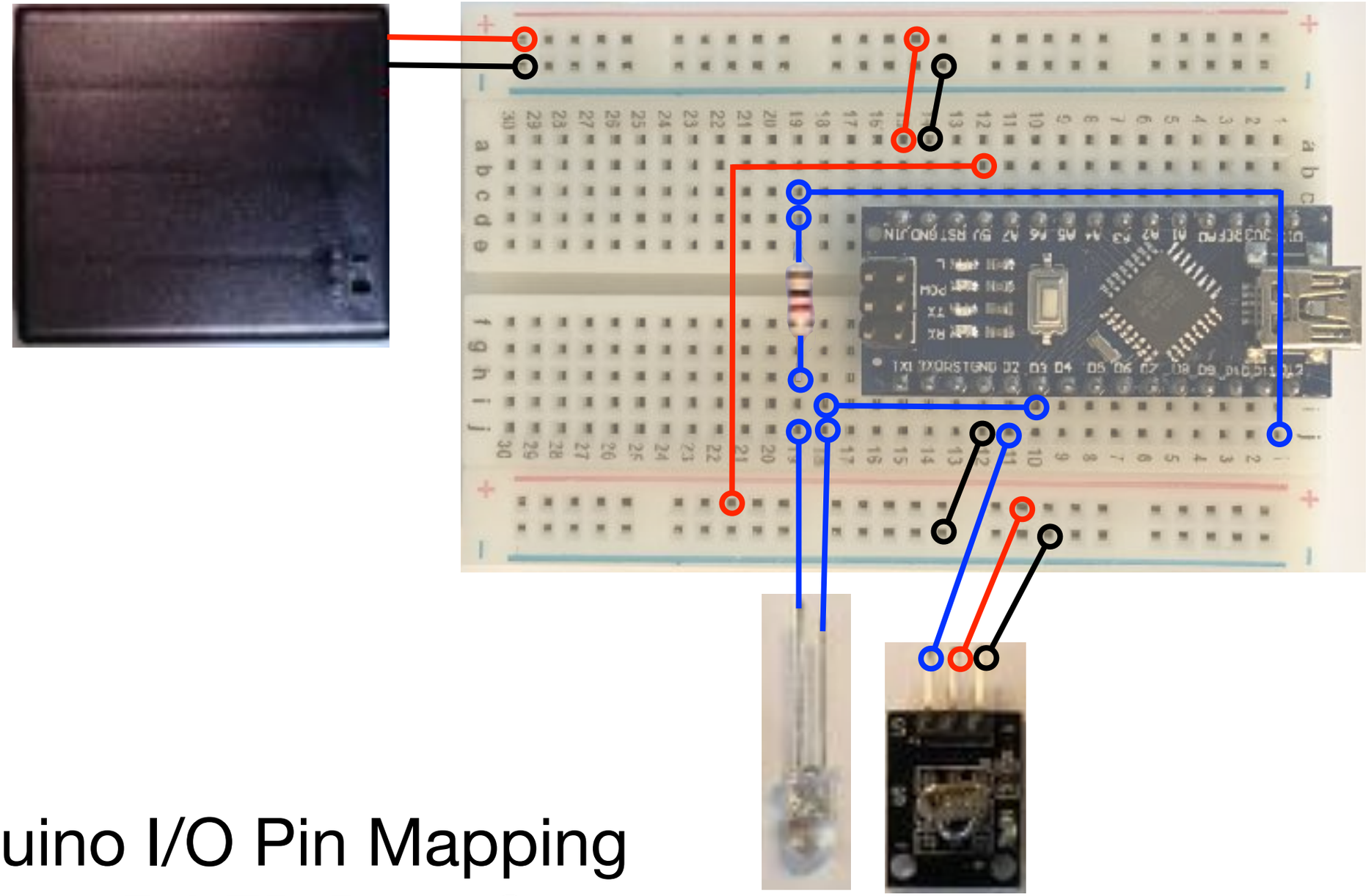
Multiple robots using this technique will interfere with each other, unless you add some extra software smarts.

Pay attention to beam width of the LED and sensing width of the receiver. Proper placement (and/or shielding) of components may be required.

Demo



Demo



Arduino I/O Pin Mapping

D12 : IR LED Data Output

D3 : IR LED Frequency Output

D2 : IR Receiver Input