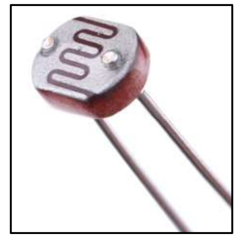
Chapter 10 – Using a Light Dependent Resistor

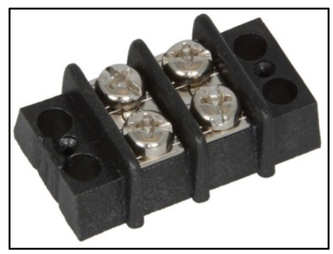
April, 2020
David Ackmann – Gateway Division NMRA



A Light Dependent Resistor (aka: LDR, photocell, photo resistor) is a small device which has differing electrical resistance depending on the amount of light falling upon it. It is usually placed between the rails of track to sense when something passes over it. I use an LDR in my Speedometer project to control a timer which calculates how long it takes for a train to complete a loop on my layout.

The leads of a LDR are symmetrical; one is the same as the other. One end is usually connected to the 5V pin on the Arduino and the other to any analog pin, in this example we will assume A0. The analog pin is also connected to a 10K resistor, which is then connected to Ground. Thus, we have a circuit as shown below:

5V-----LDR-----AnalogPin (A0) -----10KΩ-----Ground



Since the LDR is often several feet away from the Arduino, the wires connecting it to the microprocessor can be quite long. And since it is difficult to connect two wires to an Arduino pin, I usually run a wire from the pin to a barrier strip (see Chapter 5) and then wire the LDR and the 10K resistor into the same location.

One side note: I use a 10K resistor, but I have seen others use a resistor as low as 220Ω. What we learn from this is that the value of the fixed resistor is not critical, but if you use a lower value, the brightness values which are captured on the analog pin will be lower and less precise.

Earlier we said that the resistance of a LDR depends on the amount of light falling upon it. I placed an LDR on my layout and taking an Ohm meter, I tested the resistance; it read 5KΩ. I then rolled a box car over the LDR to obscure ambient light, and it read 150KΩ.

Now think of the A0 pin as a voltmeter between the two resistors, the LDR and the 10K. Remember that if the LDR is in full light it will be equivalent to a 5K resistor, and if in full darkness it will be equivalent to a 150K resistor. One end of the circuit is at 5V and the other at 0V, with the A0 pin in the middle recording the voltage value between the resistors. If there is a lot of ambient light, the total resistance of the circuit will be about

5K+10K, or 15KΩ, with about 1/3 coming from the LDR and 2/3 coming from the fixed resistor. The A0 pin knows that the total voltage is 5V, so it observes that the voltage on its pin, right between the resistors, is about 3.3V. Now consider what happens if the LDR is covered and now has 150K of resistance. The total resistance of the circuit will be 5K+150K, with over 90% of the resistance coming from the LDR; in this case the voltage as observed by the A0 pin will be well less than half a volt. In our sketch, we can test the voltage at A0 with an "analogRead" statement.

The statement as shown here will do the trick:

Resistance = analogRead(0);

The statement is generally placed inside the loop function, where the number between the parentheses represents the number of the analog pin, and the function returns an integer between 0 and 1023 representing the relative value of the voltage it observes. *Note: this is a relative value and not the absolute voltage observed!* I wrote a small program to see what values are reported in different conditions on my layout. I discovered that in ambient light, the value returned was around 700, and when darkened was around 300, but don't expect it to be a linear relationship.

So what do we do with this knowledge? I propose that we probably want to do one thing if the LDR is covered, and something else if it is not, so I compare the value to a "threshold". The threshold value I use is the average of the dark and light values, or 500. If the value returned from the analogRead function is greater than the threshold, it would indicate that the LDR **is not covered** and we might want to one thing, but if the value is lower than the threshold, it would mean the device **is covered** and we might want to do something else. In my Speedometer project, I do nothing when the ambient light is bright, and then start a timer when it darkens, indicating the start of the passage of a locomotive; I then wait while the light returns to bright (when the end of the train passes) and then wait until the LDR again darkens, indicating the return of the front of the train, at which time I calculate the speed and display the results.

Want to learn more? Check out at https://www.youtube.com/watch?v=INekoMGeXac where "Eli the Computer Guy" has a good tutorial on the topic of LDRs. Also see Paul McWhorter's LDR tutorial at https://www.youtube.com/watch?v=WMkN-uHd-Xo.

LDRs are somewhat limited in their application on model railroads, but they indeed have a unique purpose. Other electronics can perform a similar function, but I like how unobtrusive LDRs are. Yes, they don't function well in situations where the ambient light is changing, but that was not a problem for me. I hope you find them useful too.