

## **PROJECT: Light Detection**

### **Level 2 - Exercises 1 to 8**

### **Level 3 - Exercises 9 to 12**

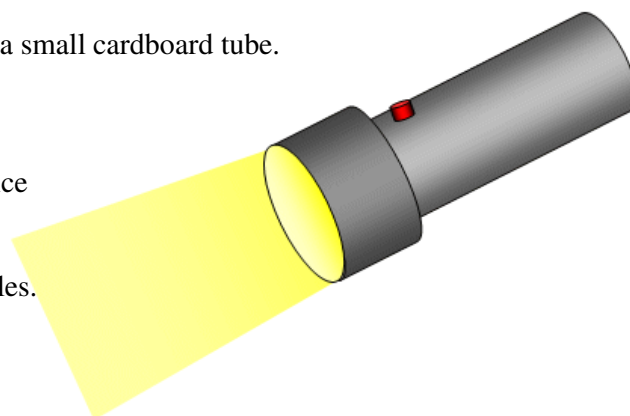
This project explores light sensing using a light dependant resistor and basic digital input and output logic, analogue measurement and information process.

This project incorporates the use of the PicPatch<sup>08</sup> microcontroller circuit board.

**Materials:** Electric torch or light source and a small cardboard tube.

### **Objective:**

Light can be detected and measured using a device called a Light Dependant Resistor (LDR). This technology is used in many applications of which this project will explore just a few examples.



### **Scope:**

#### **Detection**

Using the LDR in a resistor divider network we can use Kirchhoff's first Law to obtain a voltage which we can use to measure the level of Light sensed by the LDR.

#### **Indication**

Sound and Light can be used as a basic means to indicate the presence of light variation. This can be done by either making a Piezo beeper disk produce an audible tone or use an array of Light Emitting Diodes (LEDs) to display light intensity as a bar graph.

### **Connection Diagrams**

The microcontroller driver circuit requires the following components fitted onto the PicPatch<sup>08</sup> as illustrated in the light detection circuit diagram Figure 1.

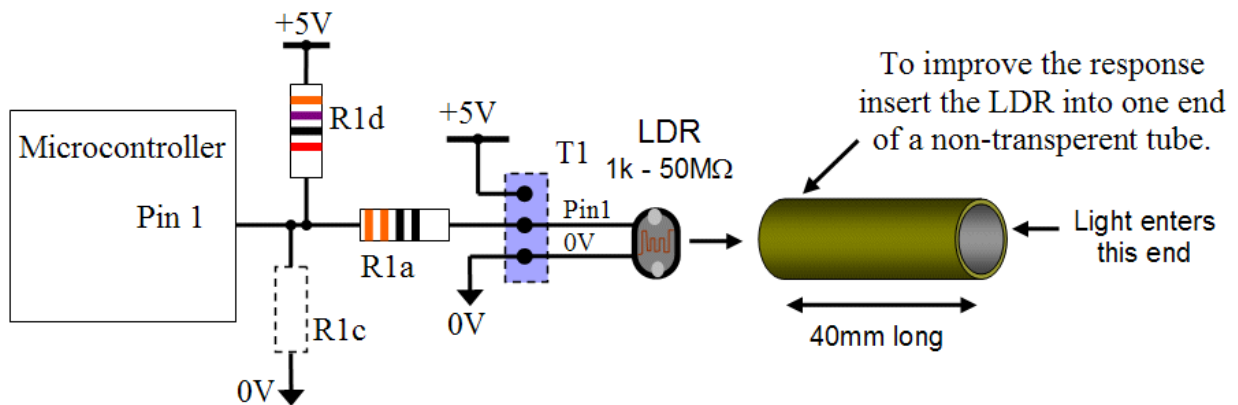
R1a = 330 $\Omega$  (330 ohm) Resistor,  
R1d = 47k $\Omega$  (47k ohm) Resistor (The pull-up resistor),  
R1b and R1c leave vacant.

#### **Option.**

For a very long cable run fit a 10nF capacitor in place of R1c.

The LDR is connected to T1 0V and Pin1.



**FIGURE 1. Light detection circuit.**

The beeper circuit requires the following components fitted;

R4a = 330Ω Resistor,

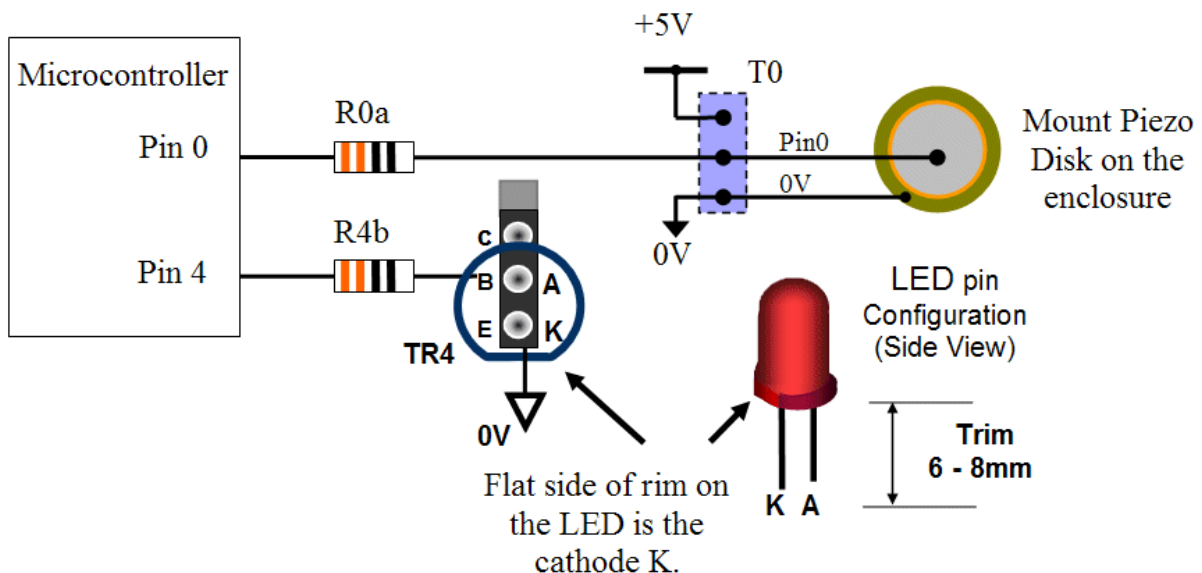
R4b = 330Ω Resistor,

TR4 = Fit an LED into TR4 SIL socket as illustrated in Figure 2.

The Piezo disk connects to T4 terminal Pin 4 and 0V as illustrated.

The Piezo beeper disk must be fixed on a firm surface for it to produce a sound.

You may wish to use double sided sticky tape or blue-tac.

**FIGURE 2. Beeper driver circuit.**

**PROGRAM 1.**

This basic program switches on the LED when the LDR is not exposed to light.  
Cover the LDR using your hand or use a non transparent cover.

Input 1	'Make Pin 1 an Input
Output 4	'make Pin 4 an Output
Loop: Pin4 = Pin1	'light shining on the LDR, Pin1 = 0 (Low) then LED is off.
Pause 1000	'Pause for 1 second,
Goto Loop	'and repeat the exercise.

**Exercises For Level 2**

1. Describe an application this technology is commonly used?
2. Set the LDR so the light emitted from the LED shines directly into the LDR.  
Shade the LDR sufficiently so that the LED activates the LDR causing the LED to toggle on and off automatically. This effect is called feedback interference.
3. Explain what precautions you should take when installing a Day-Light switch into a home so that feedback or interference is eliminated?
4. Modify program 1 so that the beeper sounds the instant the LED switches on.
5. With the beeper sounding the instant the LED switches on or off, describe an application in the home where this technology could be used as an alarm or for conserving power?

**PROGRAM 2.**

Program 2 toggles the LED on or off by waving your hand in front of the LDR.  
You may need to place the LDR into one end of a hollow tube as illustrated in Figure 1.  
This will minimise the effects of surrounding ambient light and improve sensitivity.

**'Light switch program 2**

Input 1	'make Port Pin 1 an input
Dark: Let b1 = 0	'reset the toggle flag to 0
Loop: Pause 100	'pause for 0.1 second
If Pin1 = 1 then Dark	'If Pin 1 is high (no light sensed) then no action
If b1 = 1 then Loop	'If b1 flag indicates" toggled" then no action
Let b1 = 1	'otherwise set b1 to flag the toggle action
Toggle 4	'toggle the LED either ON or OFF
Sound 0, (110, 50)	'make a tone on Port Pin 0
Goto Loop	'and repeat the exercise

6. Describe an application where this technology could be used as a hands off light switch.
7. Keeping the command line “Toggle 4” in program 2, modify the program so that the beeper sounds a high tone when the LED switches on and a lower tone for when the LED switches off. Explain who could benefit from this program.

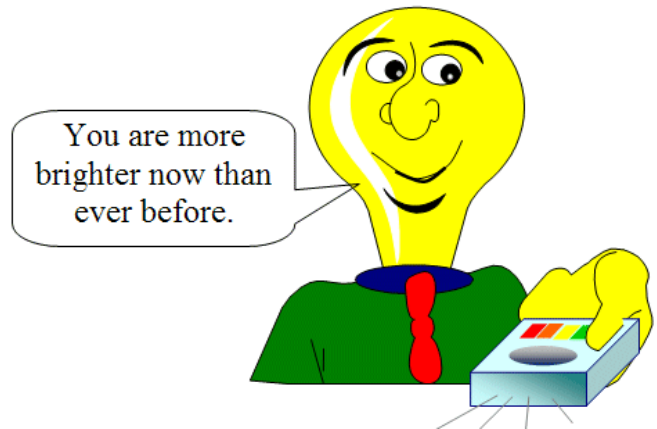
### PROGRAM 3.

This program reads an analogue level in proportion to the light sensed by the LDR. The beeper will sound more frequently with greater light intensity.

#### ‘Light beeper program 3.

Loop:	‘ <b>Note</b> - Picaxe08 (b2 = 0 to 160), Picaxe08M (b2 = 0 to 255)
Readadc 1, b2	‘Read the value at Pin 1 into register b2
W0 = b2 * 4	‘Multiply the analogue value by 5
Pause W0	‘and wait accordingly in milliseconds
Sound 4, (110, 10)	‘Make a tone on Port Pin 4
Pulsout 4, 2000	‘flash the LED on for 20 milliseconds
Goto Loop	‘and repeat the exercise

8. Explain how this technology could be utilised in practical applications for photography and safety in the industry worksite?



#### Application note:

Insert into program 3 “DEBUG b2” and view in the Debug window the value for b2.

Detecting different colours can be accomplished using different colour transparent filters placed in front of the sensor. For example using a red filter will give the lowest value for b2 when the sensor is pointed at a red or white surface.

For detecting red objects only use a red LED to shine onto the surface.

A coloured filter would not be required if the ambient light is kept to a minimum.

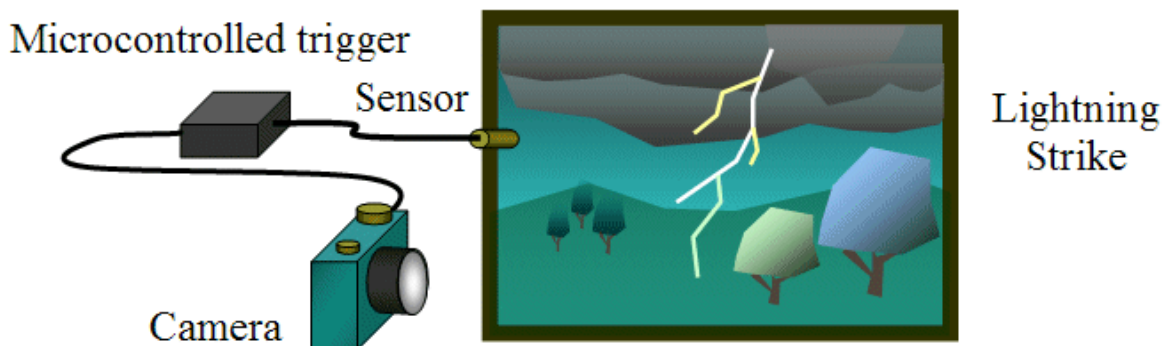
A project example could be to detect different coloured M&Ms using different coloured LEDs.

### Exercises for Level 3.

**Materials:** Electric torch or light source and a small cardboard tube.

9. Set up a circuit using three LEDs connected to Port Pins 0, 2 and 4 as illustrated in Figure 2. Write a program to indicate 4 levels of light intensity that could be used as an instrument suitable for measuring light intensity for applications described in question 8.
10. Present an idea of how this technology in question 9 could be implemented in a practical device as a hand held instrument. Provide detailed drawings of the circuit diagram, circuit board, enclosure, battery compartment and display. Keep in mind the ergonomics and features that may help the user, e.g. belt or pocket clip etc.
11. Write a program to sound an alarm when a rapid variation in light intensity is detected. Test the program by moving your hand very slowly towards the LDR so not to trigger the alarm.
12. Describe a suitable application that could use rapid light variation detection in question 11. Present a schematic diagram of the application illustrating basic electrical connections and positioning of the light detector etc.

### Example: Lightning Detection



**Tutor Information**

This project demonstrates Kirchhoff's first law to calculate the voltage of a resistor divider. The voltage that appears at Pin 1 and value of LDR resistance is inversely proportional to the level of light detected by the LDR.

**Note:** You will be able to measure the voltage across Pin 1 to 0V with a multimeter when the LDR is exposed to light. The multimeter internal resistance across the test leads will not greatly influence the circuit resistance. However if the LDR is exposed to no light the resistance of the LDR is very high and the meter internal resistance will affect the voltage measured at Pin 1.

**Answers.**

1. This circuit is used in what is called a Day-Light switch, commonly used to switch on in the evening street lights, outside house light or front entrance lights.
2. The frequency of the light flashing on and off is determined by the pause command.
3. A Day-light switch must be installed in a place so that only daylight is sensed and that no other light can cause interference such as car head-lights, outdoor house lights, moon light or street lights.
4. 'This basic program switches on the LED and sounds a beeper when no light is detected.
 

Input 1	'Make Pin 1 an Input
Output 4	'make Pin 4 an Output
Loop: If Pin4 = 1 or Pin 1 = 0 then NoBeep	
	'If LED is not already on and light is sensed then beep,
Sound 0, (110,100)	'Sound beeper the first instant the LED is switched on.
NoBeep:	
Pin4 = Pin1	'light shining on the LDR Pin1 = 0 (Low), Pin 4 = Off.
Pause 1000	'Pause for 1 second,
Goto Loop	'and repeat the exercise.
5. An alarm tells the occupants of the home that the outside light has automatically switched on for the evening, which they may then decide to switch the lights off manually to conserve power.  
Detecting car headlights up the driveway will inform the occupants of pending visitors or an intruder.

6. This technology could be used to switch on and off lights etc in hospitals or where spread of disease must be well controlled. Such a switch would require a permanent light source at all times which could be incorporated into the switch unit, a similar principle used in an optical mouse.
7. 'Light switch program 2 with different tones for when the LED is switched on and off.

Input 1	'make Port Pin 1 an input
Dark: Let b1 = 0	'reset the toggle flag to 0
Loop: Pause 100	'pause for 0.1 second
If Pin1 = 1 then Dark	'If Pin 1 is high (no light sensed) then no action
If b1 = 1 then Loop	'If b1 flag indicates" toggled" then no action
Let b1 = 1	'otherwise set b1 to flag the toggle action
b2 = Pin4 * 20	'the LED pin 4 sets the tone level (0= -0),(1= -20).
b2 = 120 - b2	'switching the LED (Off = 120 - 20),(On = 120 - 0).
Toggle 4	'toggle the LED either ON or OFF
Sound 0, (b2, 50)	'make the tone for On or OFF on Port Pin 0
Goto Loop	'and repeat the exercise

This application will help a blind person determine they have switched the light on or off.

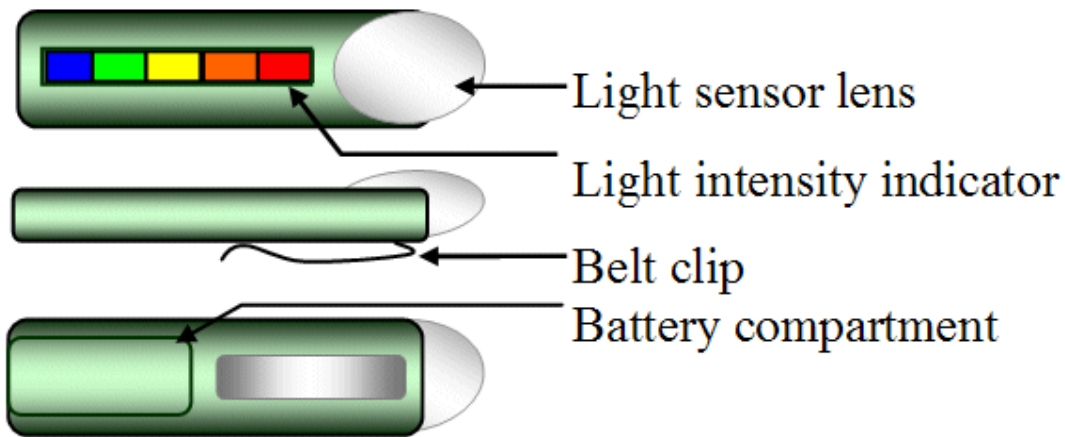
8. In photography a Lux meter is used to measure light intensity to ensure correct film exposure. Light sensors used in modern cameras automatically adjust the shutter time for best exposure. Poor lighting conditions in the industry worksite can lead to an unsafe working environment. A basic hand held instrument will inform people there is adequate lighting or not.
9. Connected the 3 LEDs the same as for Port Pin 4, with 330 $\Omega$  resistors inserted into R0b, R2b, and R4b.  
Insert LEDs into TR0, TR2, and TR4 b to e pins.

**'Four step light intensity meter, steps are OFF, LED1, LED2, LED3.**

Loop: Readadc 1, b1	'Read the light level and save into b1 register
Pins = 00000000	'Switch off all LEDs
If b1 < 75 Then LED3	'For a high intensity switch on all LEDs
If b1 < 117 Then LED2	'If a medium intensity switch on LEDs at Pins 0 & 2
If b1 < 149 Then LED1	'If a Low intensity switch on LED at Pin 0
Pulsout 0, 2000	'otherwise Pulse LED at Pin 0
Pause 100	'Pause 0.1 seconds
Goto Loop	'Repeat the exercise
LED3: High 4	'Switch on LED at Pin 4 "High Intensity"
LED2: High 2	'Switch on LED at Pin 2 "Medium Intensity"
LED1: High 0	'Switch on LED at Pin 0 "Low Intensity"
Goto Loop	'Repeat the exercise

**PLEASE NOTE:** This program is just an exercise and not to be considered calibrated light meter.

## 10. Hand held Lux meter



## 11. Rapid variation light sensor program.

Insert Debug b1 to see the effects of registers b1 to b4.

Start:	Readadc 1, b2	'First read the light level and record into the filtered register b2
Loop:	Pause 50	'Pause 50 milliseconds for each increment of the filter value
	Readadc 1, b1	'Read the light level and save into b1 register, If the intensity is
	b3 = b2 - 12	'Calculate lower filter margin
	b4 = b2 + 12	'Calculate upper filter margin
	IF b1 < b3 or b1 > b4 Then Alarm	'If intensity is outside the margins then sound alarm
Filter:	IF b1 > b2 Then INCb2	'If intensity value is less than filter value increase filter
	IF b1 < b2 Then DECB2	'If intensity value is greater then filter value decrease filter
	Goto Loop	'or repeat the exercise
INCB2:	Let b2 = b2 + 1	'Increase filter value by 1
	Goto Loop	'and repeat the exercise
DECB2:	Let b2 = b2 - 1	'Decrease filter value by 1
	Goto Loop	'and repeat the exercise
Alarm:	High 4	'Turn on LED
	Sound 0, (110,500)	'Sound alarm
	Low 0	'Turn off LED
	Low 4	'Turn off LED
	Pause 200	'Pause 0.2 seconds
	Goto Start	'and restart exercise.

12. Some applications include intruder alarm sensor, lightning detection or movement of wildlife in a nest. This would be used to trigger an alarm, counter or camera to capture the event on film. To photograph lightning the light sensor is used to trigger the camera shutter.