



# runlinc Intermediate Project 2: Radiation Counter (STEMSEL Version)

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## Introduction

### Problem

When we are in an environment with radiation, we want to make sure the level of the radiation is in the safe range. What can we do to determine the radiation level?

### Background

When we think about radiation, we often think of things like nuclear weapons and accidents like those at the Chernobyl and Fukushima nuclear reactors. However, low levels of radiation are all around us every day, from the sun to the building materials and even in our food! Brazil nuts and bananas are the two foods quite well known for being slightly radioactive. Don't worry about overeating of such foods though; you could not eat enough of them to cause any health problems (You should always try and eat a good amount of fruit anyway!).

Radiation is also very useful in many applications, many smoke detectors use a tiny amount of radioactive Americium to detect the smoke. Radiation is often used in medicine as well, including in the treatment of some cancers, viewing the inside of the body by using X-rays (radiography), radio-opaque dyes and nuclear medicine procedures. Radioactive substances can also be used in scientific research. Radiography is used in many industries for quality control or to analyse the internal working of machinery. We also use radioactive elements to energise nuclear power plants, submarines and satellites. The Curiosity Mars rover is not only powered by radioactive elements but also uses them for analysing rock and soil samples it finds on the red planet.

However, radiation can be hazardous for living things. The effects on the human body due to receiving too much radiation vary, depending on which areas of the body were exposed and how much radiation was absorbed. Radiation damages and kills the cells that make up our bodies, and may, therefore, cause burns (sunburn is caused by UV radiation), loss of white blood cells, haemorrhaging (bleeding), fatigue and weakness and even cancer. If radiation damages vital organs like the brain, heart, lungs, digestive tract etc., then the effects will be more severe than if only the surface of your skin or your hand was affected.

Despite these dangers, people must sometimes enter dangerous radioactive zones. For example, people have been cleaning up the areas around the Fukushima nuclear reactor in Japan or when people are working in the places where radioactive compounds are used or stored such as a research centre or even in outer space. They often carry measuring devices like Geiger counters to help them measure how much radiation they have been exposed to. It is crucial to consider the level of radiation they have been exposed to, as well as the length of time they were exposed. If there was only a low radiation level, you could stay in the area for a longer time without any negative effects than if the radiation level was higher. For today's project, we will implement a counter to keep track of the total amount of radiation we have been exposed to. We will be using a safer type of radiation though, simply measuring the amount of light.

Note: Yes, (visible) light is a type of radiation. Much like radio waves, microwaves, infrared and x-rays are all radiation and are part of the electromagnetic spectrum. The danger in radiation generally comes with how short the wavelength for the type is. Types with longer 2 wavelengths such as radio waves are safer than gamma waves or x-rays, which have significantly shorter wavelengths and have more energy per packet of light.

## Ideas

How can we measure the radiation (light) level? How can the microchip and runlinc tell the user if the level is high or low? How can we make our device count up faster the more radiation is detected? Is a visual warning on a webpage enough, or would the additional method be advantageous? What kind of thresholds might be good? Is there any other information that might be good to display on our Webpage?

## Plan

We can use an LDR as our light sensor and display the level on using a webpage.

INPUTS

OUTPUTS

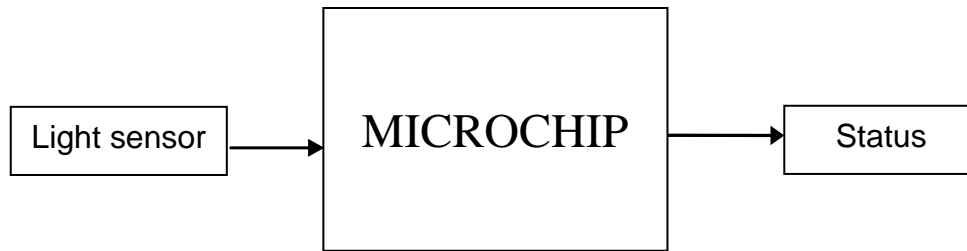


Figure 1 Block diagram of Microchip outputs

## runlinc Background

Runlinc is a web page inside a Wi-Fi chip. The programming is done in the browser and sent to the chip over Wi-Fi. The runlinc web page inside the Wi-Fi chip will command the microchips to do sensing, control, data logging Internet of Things (IoT). It can predict and command.

## Part A: Design the Circuit on runlinc

**Note:** Refer to runlinc Wi-Fi Setup Guide document to connect to runlinc

Use the left side of the runlinc web page to construct an input/output (I/O).

For port C7, name it RAD\_Sensor and set it as ANALOG\_IN.

In our circuit design, we will be using the light sensor. We happen to have this in our kits, so these can be used on our circuit design, as per the plan.

PORT	CONFIGURATION	NAME	STATUS
A3	DISABLED		
B4	DISABLED		
B6	DISABLED		
C0	DISABLED		
C1	DISABLED		
C2	DISABLED		
C3	DISABLED		
C4	DISABLED		
C5	DISABLED		
C6	DISABLED		
C7	ANALOG_IN	RAD_Sensor	225

Network Status: Active

Figure 2 I/O configurations connections

## Part B: Build the Circuit

Use the runlinc I/O to connect the hardware. Remember that turning the screws clockwise will close the clamps and turning the screws anticlockwise will open them. All black wires should go in the negative (-) terminal, red wires go in the positive (+) terminal, and white wires go in the terminal we designated in the runlinc web page port.

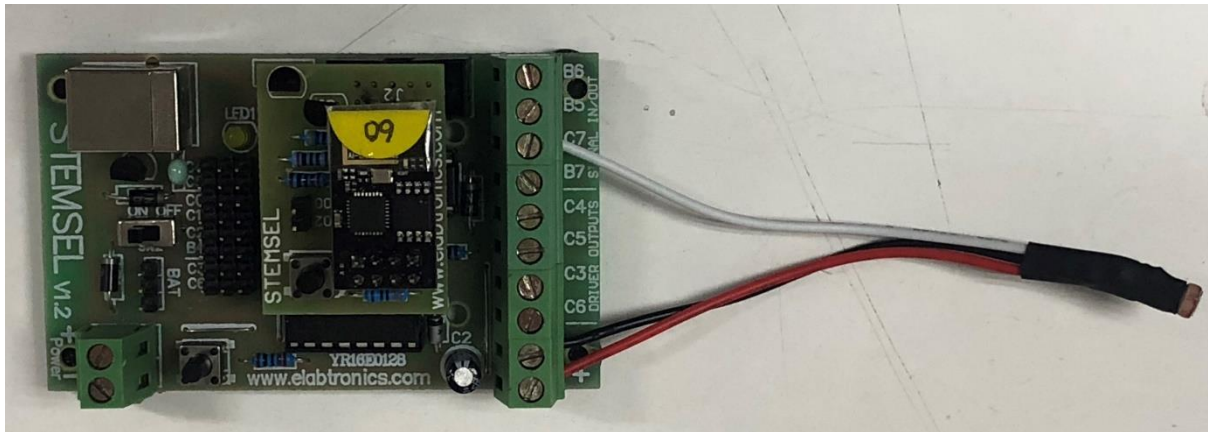


Figure 3 Circuit connection on the microcontroller

### Wiring instructions

- a.) For the lightsensor connect the white wire to C7, black wire to negative port and red wire to positive port.

## Part C: Program the Circuit

Now we can start to program the functions of the radiation counter. To do this, HTML and JavaScript Loop are needed.

For **HTML** box type the following:

```
<h2>runlinc Radiation Counter</h2>
Radioactivity:
<font id=RadNow></font> Curie
```

This will set up our webpage to receive the Information from the RAD\_Sensor.

For **JavaScript Loop** type the following code:

```
sense_num = analogIn(RAD_Sensor);
sense_num = sense_num / 51;
Curie = sense_num.toFixed(2);
document.getElementById('RadNow').innerHTML = Curie;
```

Here, a variable is initialised with it containing the light level read from the light sensor.

Then, we are sending it to the HTML webpage so it can be displayed.

At this stage, save and run the code and have a look at what you get. If it doesn't work, go through your code and check for any errors.

Now we can expand on what has been done to now display the radiation level. To do this, we will need to add to the HTML script and the JavaScript Loop as well as the JavaScript.

For **HTML** box, typing the following under what has already been done:

```
<br>
<font face="verdana" id=TotRads></font> Rads
```

For the **JavaScript** box, typing the following:

```
let sense_num = analogIn(RAD_Sensor);
let total_rads = 0;
```

For the **JavaScript Loop** box, typing the following under what has already been done:

```
total_rads = total_rads + sense_num;
await mSec( 500 );
document.getElementById('TotRads').innerHTML = total_rads.toFixed(2);
```

Now Save and run the code and see what's new. If it's not working double check your code for any errors, barring any errors before refresh the page and load in your program to try again.

Then we're going to create the alerts, to do this we're going to add extra content to the HTML box and the JavaScript Loop box.

For **HTML** box, typing the following under what has already been done:

```
<br>
<font id=Message></font>
```

For the **JavaScript Loop** box, typing the following under what has already been done:

```
if(sense_num < 2)
  document.getElementById('Message').innerHTML = "Too LOW";
else
  document.getElementById('Message').innerHTML = "Too HIGH";
```

Once again save the code and run it. If it doesn't work, check your code for any errors if no errors refresh the page and reload your code then try and rerun it.

**Final Code:**

```
<h2>runlinc Radiation Counter</h2>
Radioactivity:
<font id=RadNow></font> Curie
<br>
<font face="verdana" id=TotRads></font> Rads
<br>
<font id=Message></font>
```

Figure 4 HTML Code

```
let sense_num = analogIn(RAD_Sensor);
let total_rads = 0;
```

Figure 5 JavaScript Code

```
sense_num = analogIn(RAD_Sensor);
sense_num = sense_num / 51;
Curie = sense_num.toFixed(2);
document.getElementById('RadNow').innerHTML = Curie;

total_rads = total_rads + sense_num;
await mSec( 500 );
document.getElementById('TotRads').innerHTML = total_rads.toFixed(2);

if(sense_num < 2)
  document.getElementById('Message').innerHTML = "Too LOW";
else
  document.getElementById('Message').innerHTML = "Too HIGH";
```

Figure 6 JavaScript Loop Code

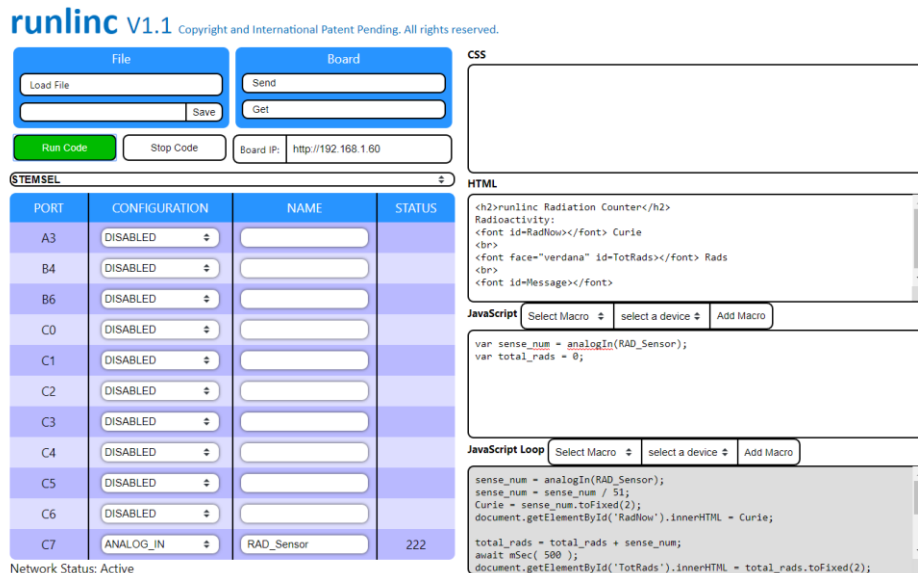


Figure 4 Runlinc Image

**Summary**

We are surrounded by radiation every day, and although it is useful, radiation can cause severe and ongoing health problems. We need to be careful of how much radiation we are exposed to, so people working in areas with high radiation need to monitor their exposure with devices similar to the one we made in this project.