STEMSEL Intermediate Project 5:
Global Warning - Temperature Sniffer

Problem
To better understand how to find the average temperature of the earth, we need to create a test instrument to find the minimum and maximum temperature points in a room.

Background
It's become quite common to hear people talking about global warming since 1990, but how can global warming change our lives, and why it is so important that countries unite together to reduce their carbon footprint?

For 2.5 million years, the Earth's climate has cycled from ice ages to warm periods, but in the last century the temperature on this planet has increased unusually fast, about 1.2 to 1.4 F^0. You may think that is a very small difference and there is no need to worry, right?

Wrong, no matter how astonishing it is, the fact is that this planet and the biosphere is very fragile, and even this small change can have severe effects, such as rising sea levels which can flood low-lying areas, as well as lead to adverse weather patterns, like powerful storms or droughts.

So what causes global warming? Certain types of gas present in the Earth's atmosphere such as carbon dioxide and methane are able to trap heat like a blanket. These gases are called greenhouse gases because they keep the Earth warn like a greenhouse. This is usually a good thing since it keeps the Earth warm enough to support life. However, when we burn fossil fuels like petrol, coal or gas lots of carbon dioxide is created, and this extra carbon dioxide is keeping the Earth too hot, which causes the problems mentioned above.
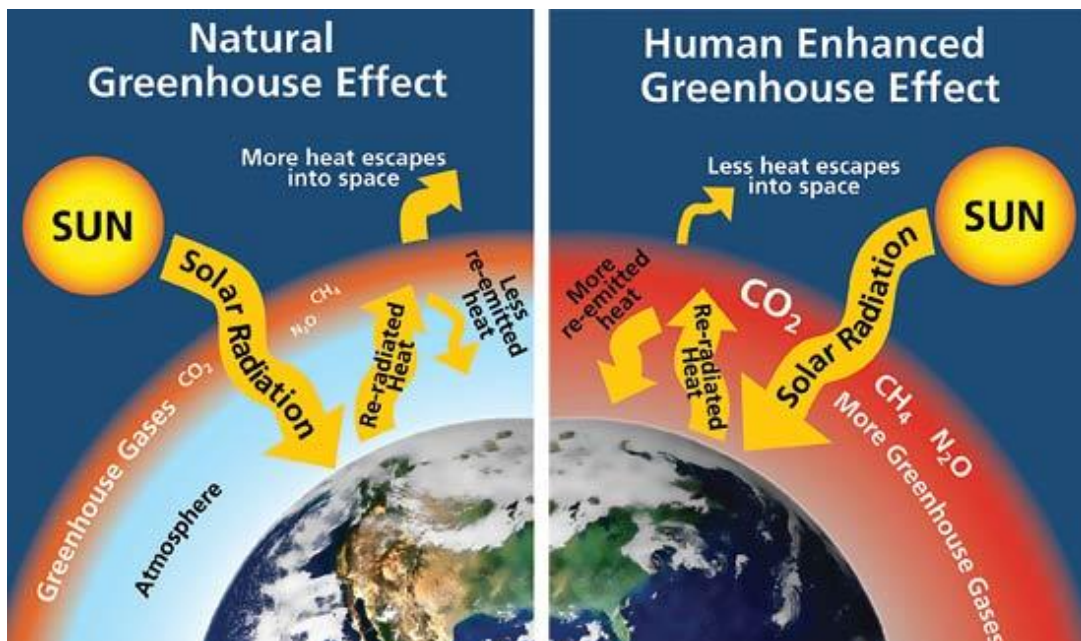

Figure 1 - the greenhouse effect

So how can we monitor the temperature of earth, or even more, how can we protect our environment from global warming? The development of satellite remote sensing technology provided an effective method of monitoring the temperature on Earth.

Geoscientists nowadays use the data sent from numerous satellites to analyze and predict the effects of global warming.

Don't worry, you are not going to build a remote sensor used on a satellite, however in this project you will design and build a portable temperature sensor which can detect the maximum and minimum temperatures in this room.

Ideas

What can we use to detect the temperature? How can we display the temperature? We can't see the actual temperature, so could we instead make our circuit display if the temperature is hotter or colder than the previous temperature? How could we show that the temperature is hotter? Colder? What if the temperature is the same? Should we be able to reset the temperature that we compare with and how can we do that?

Plan

Our circuit will have a set temperature and can show us if the current temperature is higher, lower or the same as the set temperature. We will use a thermistor to detect the temperature, and a couple of LEDs to display if the temperature is higher or lower. We will use the red LED to show the temperature is hotter, and the green LED to show a colder temperature. If the current temperature is the same as our set temperature, we will light up the yellow LED on the STEMSEL controller board. The button can be used to reset the set temperature.

When we start the temperature sniffer, it should record the temperature and save it as the set temperature (i.e. a threshold). It should then start continuously reading the current temperature, and turn on one of the LEDs depending on if the current temperature is higher, lower, or the same as the set temperature. We can also use the push button to reset the set temperature, so that if we find a higher temperature we can make it our set temperature then try to find a place that is even hotter. By repeatedly doing this we will eventually find the hottest part of the room, i.e. the maximum temperature.
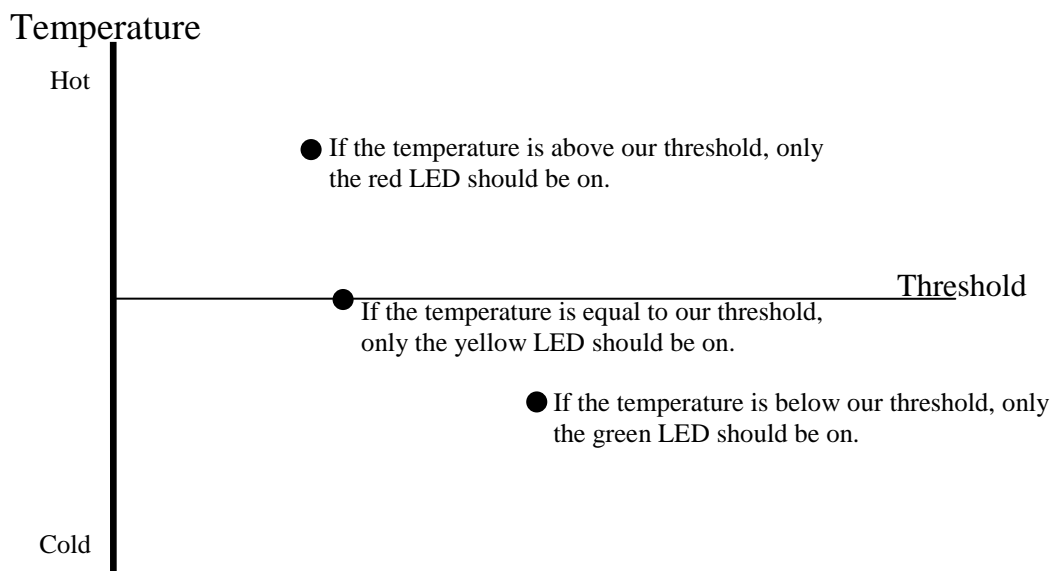
Temperature

Hot

● If the temperature is above our threshold, only the red LED should be on.

● Threshold
If the temperature is equal to our threshold, only the yellow LED should be on.

● If the temperature is below our threshold, only the green LED should be on.

Cold

Figure 2 - Action of the temperature sniffer

Design

Open ezCircuitDesigner and start a new STEMSEL project, add the thermistor and LEDs to the project as in the image below. You may notice that when you click an icon, some pins of the STEMSEL controller board will become light green, that's the recommended pin to connect this component. After you add a component, you can right-click the component to rename it, for example we rename the red LED to "redhigher" since we want it to light up when the temperature is higher than the set value.   Your design should look like this:
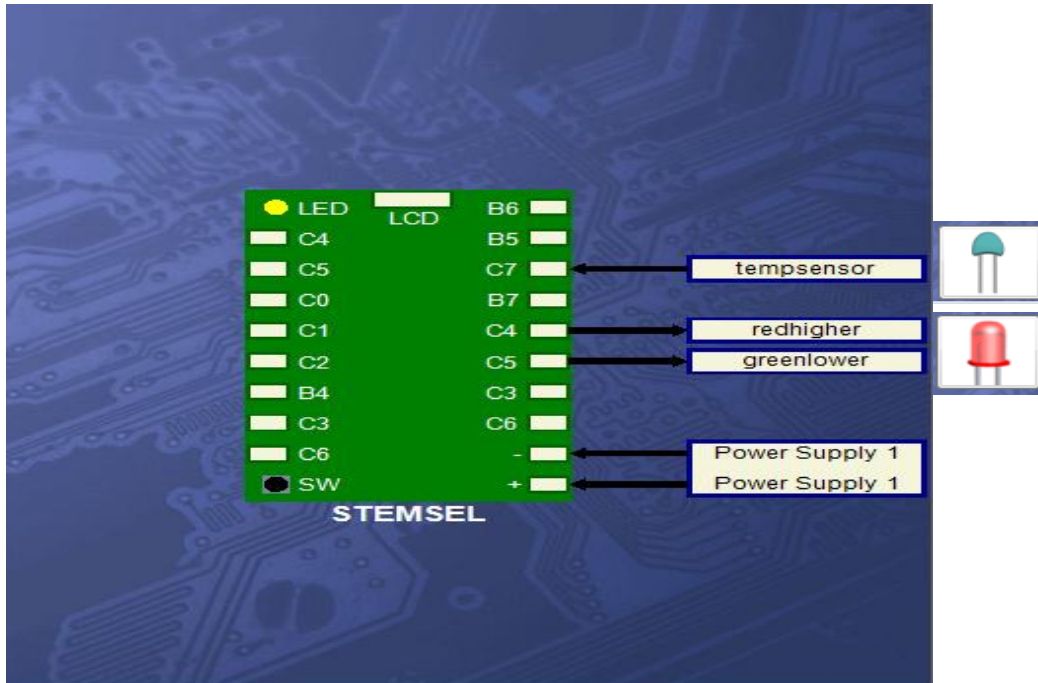

Figure 3 – circuit design

Build the circuit

When you have finished designing the circuit, it's time to assemble it using your kit. Put all of the black wires into the negative (-) pin, and the red wire into the positive (+) pin. Now if you are a cool kid, you will notice that the labels next to the pins on this diagram (like B6, B5 C7, etc.) correspond to those on the actual STEMSEL controller board. Yes, put the white leads of the components into the corresponding hole on STEMSEL controller board and screw tight.
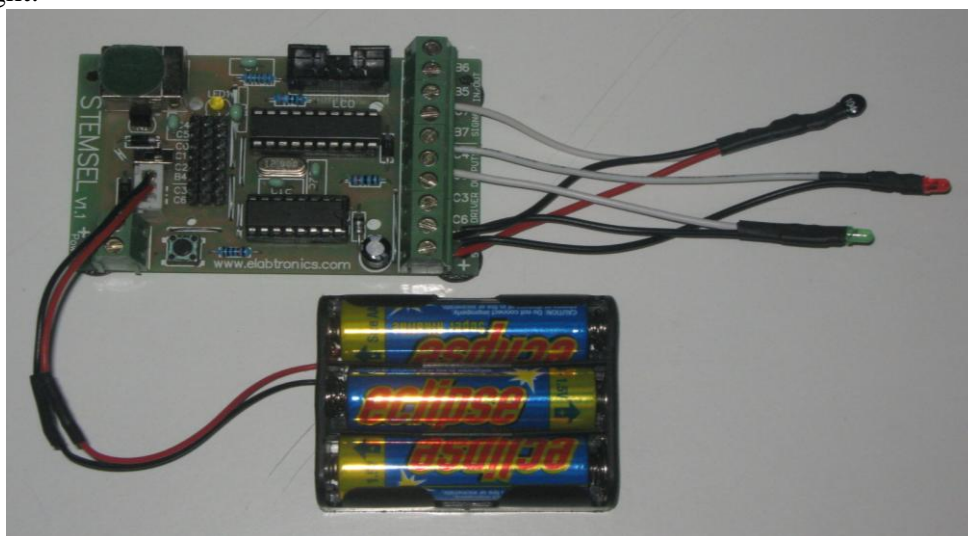

Figure 4 - circuit

3

Programming

Once you have assembled the circuit, send the design to Corechart by clicking the "Send to Corechart" button, then click the "Send Program To Chip" button to program the chip with the LED test program. Once you have verified that the LEDs are working correctly, delete the test routines so we can start writing our program.

According to our plan, we want our program to set a threshold temperature which can be compared to the current temperature. If the current temperature is hotter than the threshold, we will turn on the red LED, if it is colder than the threshold we will turn on the green LED, and we will turn on the yellow LED if the temperature is the same.

1. The first step is to read in the temperature of the environment using an **Analog_In** icon, which can be found by clicking the **Inputs** button. Double click the new AnalogIn icon to open the properties box, and select "tempsensor" as the INPUT PIN, then save it as "tempnow". Click OK.

2. Next, we will check if this should be the threshold temperature by adding a Decision icon to see if the pushbutton is being pressed. Click the new Decision icon and select "If **A3_PushButton** is **OFF**" in "Icon Properties" window at right and then click "apply".

3. Now we store the current temperature as our threshold which we will call "tempsetting". Click the **Numbers** button, and select **Set_Number** from the Icon properties list. Double click the new icon, save "**tempnow**" as "**tempsetting**" and click OK.

4. Next, we will compare the temperature with the value that we set, and turn on the appropriate LED. Click the **Numbers** button, and select the **Compare** option from the Icon Properties list, then place the new icon after the previous action. Use the Compare icon to compare **tempnow** with **tempsetting**, and tick the above, below and equal checkboxes so the microchip can do something if the temperature is higher, lower or equal to the tempsetting.

5. Now ezSystem will automatically generate three blank conditional actions for you that can be used to turn on the outputs in certain cases. For example, we want the green LED to be turned on when the temperature is lower than tempsetting.

6. If **tempnow** is below **tempsetting**, then turn on the green LED, and turn off the red and yellow LEDs. Similarly, if tempnow is above tempsetting, turn on the red LED and turn off the green and yellow LEDs. If the two temperatures are equal, then only the yellow LED should be on. These icons will need to be put into groups so that they will fit beneath the above, below and equal decision icons. Please see Fig 5 for reference.

7. Add a GOTO START icon at the end of the program, and then send the program to chip.

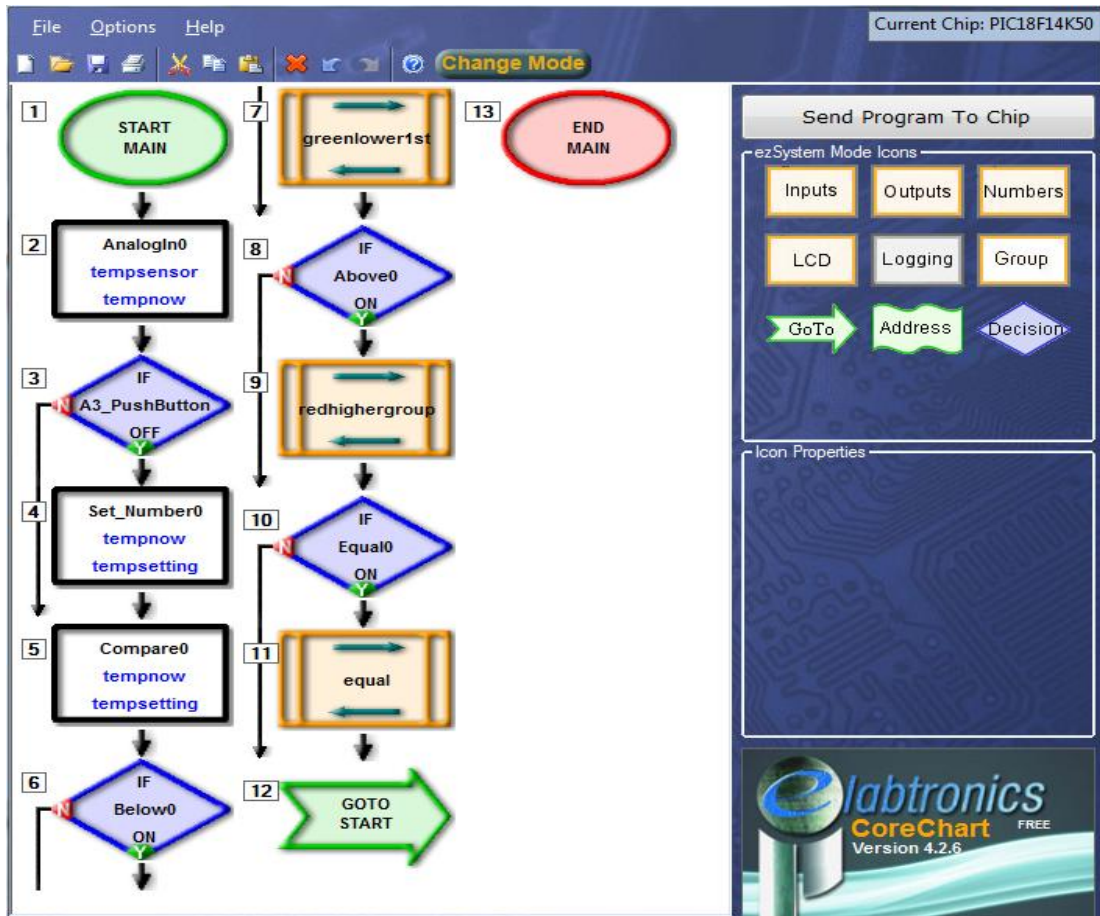Now your program should look like this:

Figure 5 – the control program

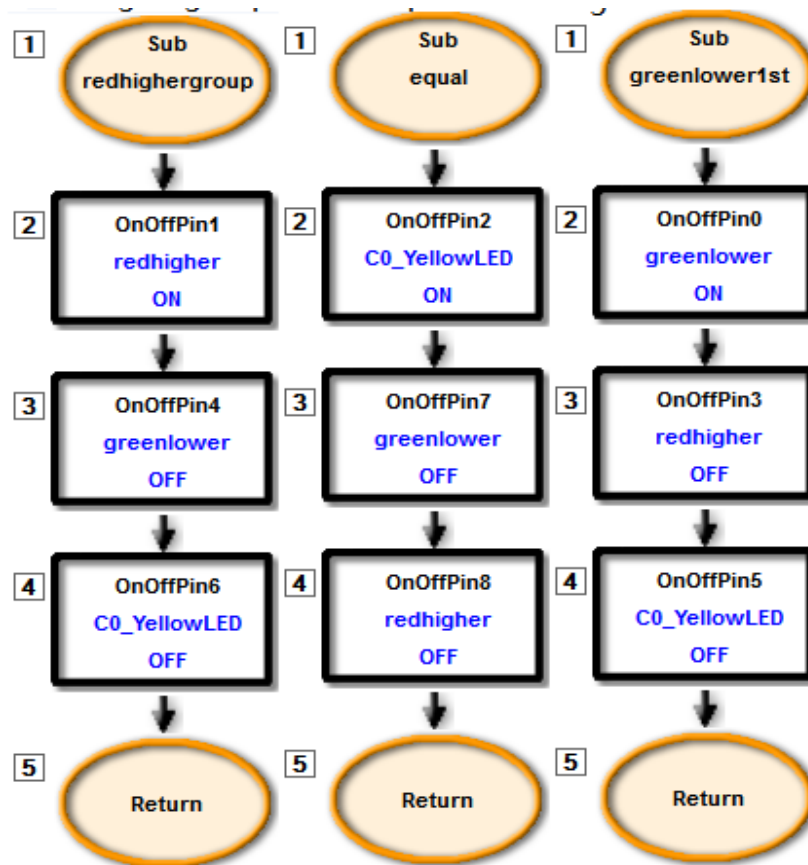This is what is inside each group:

Figure 6 – Subroutine contents

After you send the program to the chip, press the push button on the STEMSEL controller board to set the threshold temperature. Now the yellow LED should light up since it's the same temperature. Walk around or warm the sensor by holding it to see if the red LED will light up.

Activity

Use your new device to try to find the minimum and maximum temperatures in the room. To find the maximum, find a place that is hotter than your original temperature, then press the pushbutton to make this the new set temperature. If you find a place that's even hotter, press the button again and keep searching. If you can't find anywhere that is hotter than your current threshold, then that was the maximum temperature. Do the same looking for colder places to find the minimum temperature.

Summary

By using a temperature dependent resistor, some LEDs and a microchip, we can measure and compare the temperature in this room. During this project, we learned how we can use the microchip to compare two temperature samples.   Although this project is far simpler than a resource monitoring satellite, some of the principles are exactly the same. This is a connection of engineering; all the complicated projects, all the complicated technological applications can be broken down into simple principles. However working out how to link all these principles together is very difficult, and needs thousands of scientists and engineers to dedicate their knowledge over several years.