Greenhouse Controller

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Introduction

In this user guide you will learn how to build your own greenhouse controller. You will find the materials you need, instructions on how to build the circuit and how to interact with the controller. You will also learn how to read and set up sensor addresses. Each instruction is described and explained step by step.

The system automatically controls a heater, window and water atomizer to maintain temperature and humidity respectively. Each sensor is read once per second. The values are averaged and saved every 15 minutes. These values can then be read out. There is also a control available, which displays the values and the controlled systems (heating, etc.) every second.

Component list

There are a few components you will need for this project. Below you will find a list of the required materials.

Amount	Object	Description
1x	PSOC controller	Controller for the greenhouse
1x	Breadboard	For plugging the circuit
1x	DHT11	Sensor for air temperature and humidity
1x	Micro Servo 9g	Stepper motor to open Window
1x	Capacitive Soil Moisture Sensor v2	Sensor to measure the soil Moisture
3x	4.7kΩ Resistor	Pullup resistor
2x	ds18b20+	Sensor for soil temperature
Some	Wires, e.g. Jumper wires	Wires to connect sensors and controller

Below you will find a listing of the corresponding data sheets and links to reliable dealers. You can find the datasheets later in the wiring diagram again.

Component	Link to datasheet	Link to supplier
DHT11	DHT11 Datasheet	Buy DHT11
Micro Servo 9g	Micro Servo 9g Datasheet	Buy Servo motor
Capacitive Soil Moisture Sensor	None	Buy Capacitive Soil Moisture Sensor
4.7kΩ resistor	None	Buy Resistor
Dallas 18b20+	ds18b20+ Datasheet	Buy ds18b20+
Jumper wire	None	Buy Jumper wire

Wiring Diagram

In the following part you see the wiring step by step. The color of the cables has the same meaning everywhere. It is recommended to look up the pinout of each component before inserting them. Swapping pins can cause the components to heat up or even be destroyed.

Color	Meaning
Red	VDD / +5V
Black	GND / 0V
Yellow	Data

If you know how to set up all pins with pullup resistors, you can see the pin assignment list below. If you don't know how to do that, no problem. In the following everything is described step by step, where which cable must be plugged in. You will find the corresponding pictures. Since the PSOC has only a limited number of VDD and GND pins, it is advisable to nurse the sec rights connections on your breadboard to be able to reach VDD and GND at each position.

Pin assignment

Components signal pin	Controller pin
DHT11	12.3
Servo motor 9g	2.0
Capacitive moisture sensor v2	0.0
Soil temperature sensors	2.6

Connect DHT11 sensor

Let’s start with the DHT11 sensor. Connect the +pin from the sensor with the VDD connection of the board(+5V) and the –pin with the GND (0V). The signal pin is not that easy as the other two pins. Connect the pullup resistor of 4.7kΩ with the signal pin and the VDD pin of the connector. Then connect the signal pin with pin 12.3 of the controller. It should look like this:

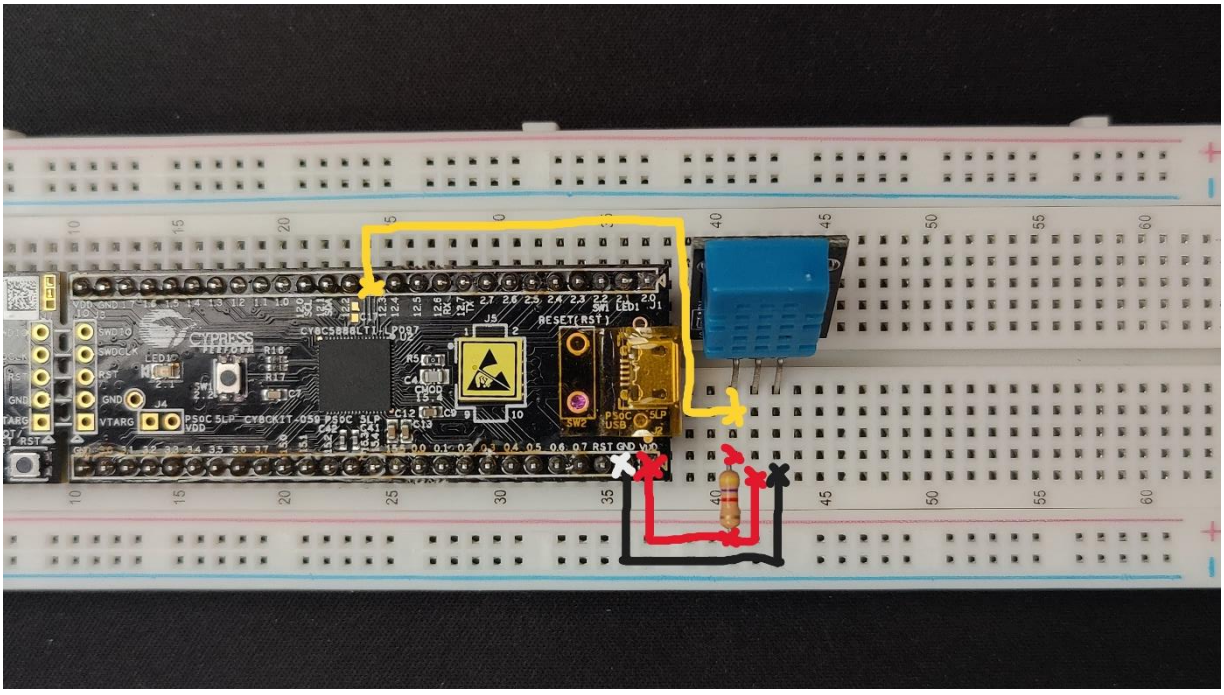

Figure 1: Wiring diagram of the DHT11

Connect servo motor 9g

The next step is to connect the Servo motor, to control the window later on. The Servo motor connection is just simple forward. Connect the +pin with VDD and the -pin with GND. The signal pin could be connected with the 2.0 pin of the controller. It should look like this:

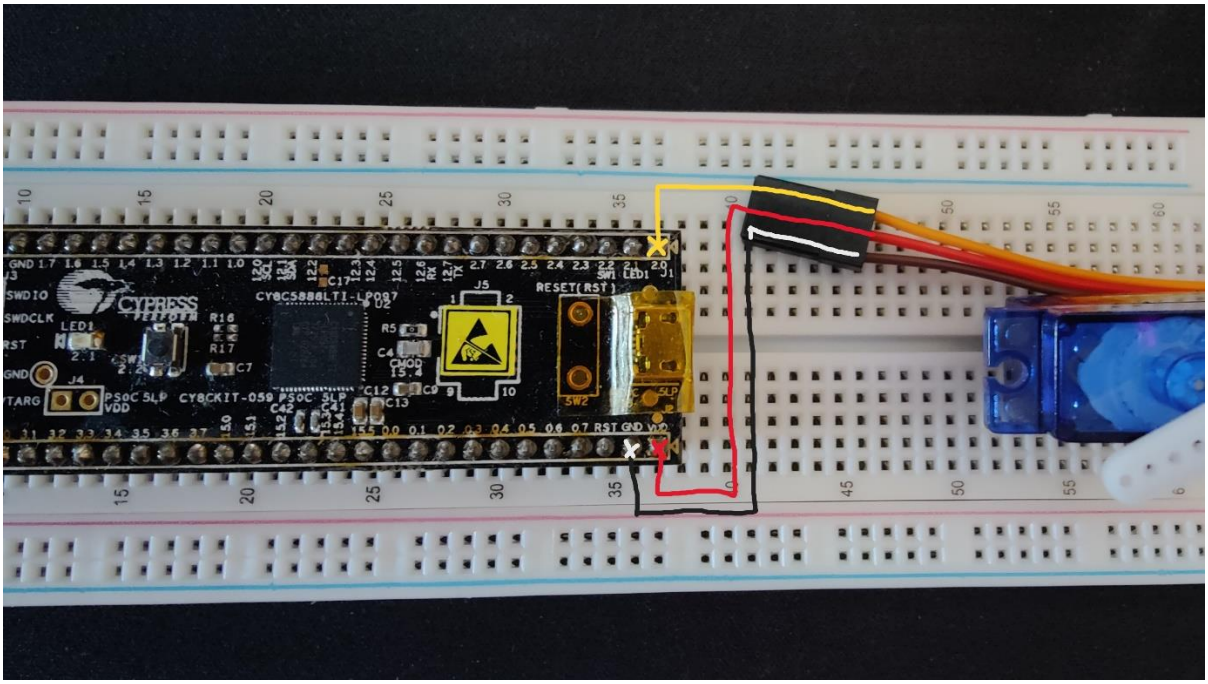

Figure 2: Wiring diagram of the Micro Servo 9g

Connect soil moisture sensor

The soil moisture sensor is as easy as the Servo motor. Plug the +pin to VDD, the -pin to GND and the signal pint to 0.0 of the controller.

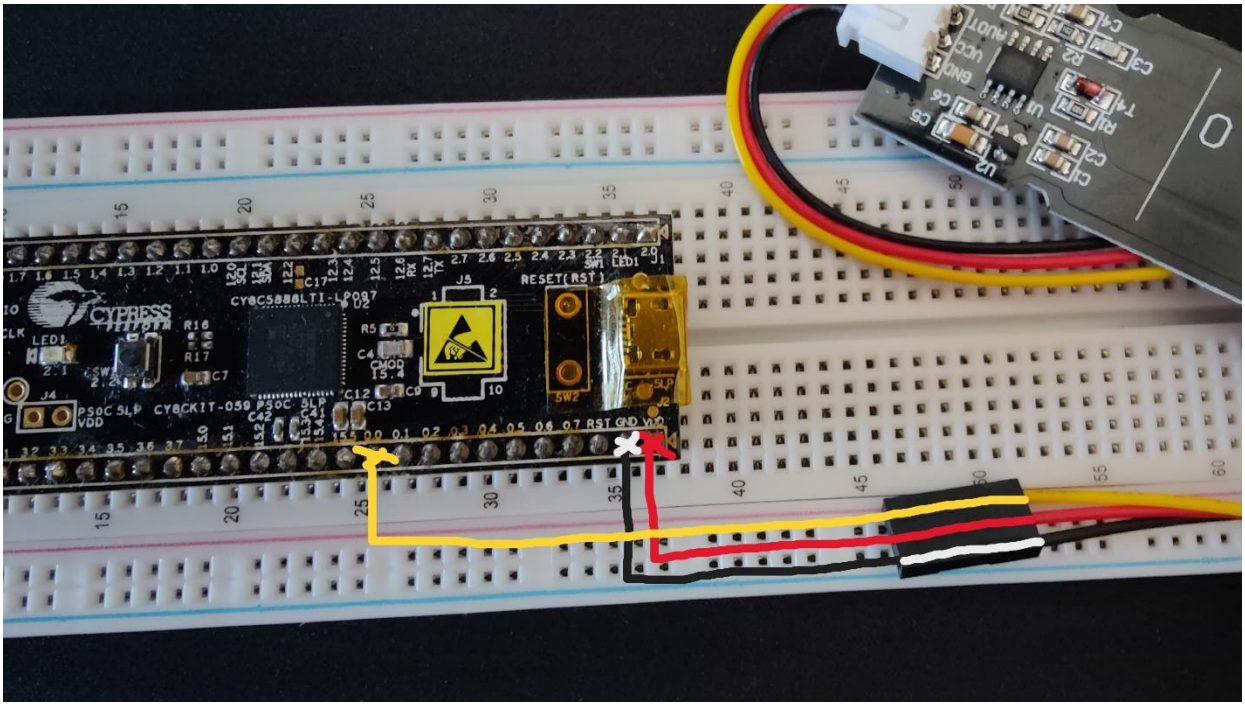

Figure 3: Wiring diagram of the Capacitive Soil Moisture Sensor v2

Connect ds18b20+ sensors via One Wire

The last sensors you have to connect are the two ds18b20+ sensors, which are controlled with One Wire principle. Do the next step for both of the sensors. Connect the pullup resistor of 4.7kΩ with VDD and the signal pin of the sensor. Then connect the +pint with VDD and the -pin with GND.

Now connect the signal pin of the first sensor with the signal pin of the second. If these pins are connected, connect the signal pins with the 2.6pin of the controller.

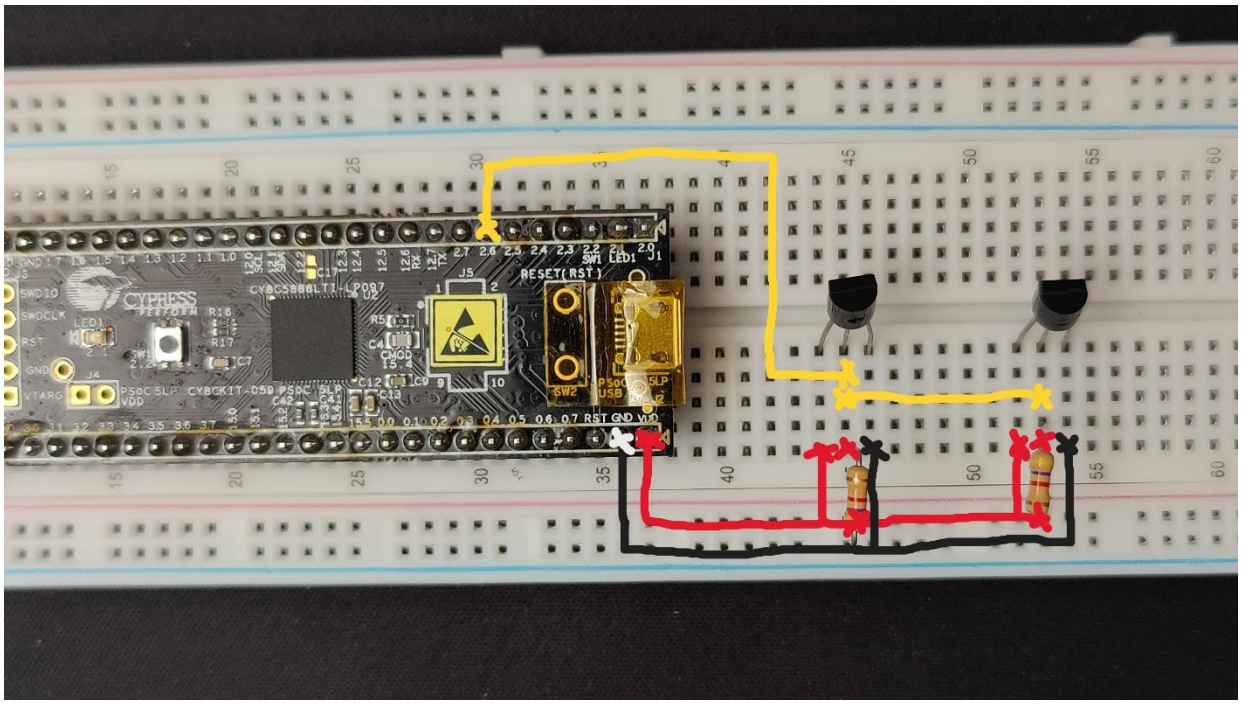

Figure 4: Wiring diagram of the two Soil temperature sensors

Program and communicate with the controller

After plugging in the circuit, the program must be written to the PSOC. For this we recommend e.g., PSOC Creator form Infinion. You also need a program like PuTTY to communicate with the controller. connect your controller to the computer and open PuTTY. To establish a connection with the controller set the connection type to "Serial", enter the corresponding COM port and set the speed to "115200". If you press now on "Open" a console opens, with which you can access the controller.

Now open the file "Greenhouse.cywrk" with PSOC Creator and program it to the controller. This was successful if the controller outputs "System started up!" and then displays the command terminal.

However, as you can see, the controller still returns an error, which we now have to take care of. When the system is set up for the first time or one of the soil temperature sensors is replaced, the address of the sensors must still be determined. This is described in the next section 'Setup sensor Addresses'.

Setup sensor addresses

When the above steps have been completed, only the addresses of the soil temperature sensors (ds18b20+) must be read in for the controller to be fully operational. This must also be done if a sensor has been replaced. The addresses are recognized by the program itself and no additional program is needed. To determine the addresses of a sensor, enter the command 'E' to get to the setup. From now on you only have to follow the instructions of the program. First remove one of the two soil temperature sensors so that only one is connected to the controller. You can simply pull out the sensor and leave the rest of the circuit. When only one soil temperature sensor is plugged in, press 'ENTER' and the address of this sensor will be determined, printed and stored. Now change the sensor and press 'ENTER' again to read in the address of the second sensor. This address is also stored and printed. The program confirms that the setup is completed. Now you can plug in the second sensor again and use the controller in normal operation.

WARNING:

Do not insert both or more than one ds18b20+ sensors or other sensors communicating via One Wire. As a result, data can be lost and the addresses cannot be determined correctly.

You can only finish the setup by resetting the controller, which is not recommended. Once you have started the setup, run it to the end. During the setup you cannot enter any commands, except 'ENTER' to go to the next step.

Now everything is done and you can use the controller as a Greenhouse controller. Below you will find how to enter commands and what options the system provides.

Command interface

There are some commands that you can use to control the controller. You do not have to remember the commands. The commands are issued after each restart of the controller and at any time after pressing 'ESC' on the console. Using the commands is very simple. Below you can see the command terminal and how to enter a command.

```
Command terminal:
 '?'             -Print general information
 'T?'            -Print current time
 'T hh:mm'       -Set time to hh:mm
 'D?'            -Print current date
 'D dd/mm/yyyy'  -Set date to dd/mm/yyyy
 'A'             -Print saves from last 24h(latest at last)
 'C'             -Delete saves
 'S'             -Views live data and controls
Press 'ESC' at any time to see the menu again
```

Figure 5: Command terminal

Input	Description
?	Print general information
T?	Print the current time to console
T hh:mm	Saves the inserted time with the format hh:mm (00:00-23:59)
D?	Prints the current date to console in the format DD.MM.YYYY
D dd/mm/yyyy	Saves the inserted date
A	Prints saved data from the last 24 hours. Newest safe at last.
C	Deletes all saves except the current time and date.
S	Print live data and controls
'ESC'	Print command terminal and quit live data view
'DELETE'	Delete last input
'ENTER'	Accept input
Commands not shown	
E	Setup menu to read sensor address

Insert a command

The commands can be entered as lower-case letters as well as upper case letters. The important thing is the formatting. Every space and every special character is required as specified (the ' as they appear in the command terminal are not required). For example, for the input of a new date, under the format dd/mm/yyyy, the input is: d 13/06/2023. Every space of the format must be filled.

Errors and warnings

Unknown, defect sensor

If the program receives a wrong value from the earth temperature sensors, the program recognizes that there is an error and this message appears:

"WARNING

At least one of the soil temperature sensors is defective, not addressed correctly or not plugged in correctly. Please check your circuit and make sure that the addresses are correct. To change the addresses, press 'E' and follow the instructions."

We recommend proceeding systematically. If you are using the program for the first time or have installed a new sensor, do the setup (press 'E'). If this is not the case, we recommend to check the circuit. If these two possibilities did not help, try another sensor and do the setup to get to know the new sensor address.

Invalid input

In case of a not allowed input or a wrong command, the program recognizes this and gives an error. This error can also appear when accessing the running system. In this case, the controller needs to be reset (no data is lost, but the save interval is reset and the system takes 15 minutes to save again).

"Invalid input, please try it again!"

Try the input again and make sure to comply the form.