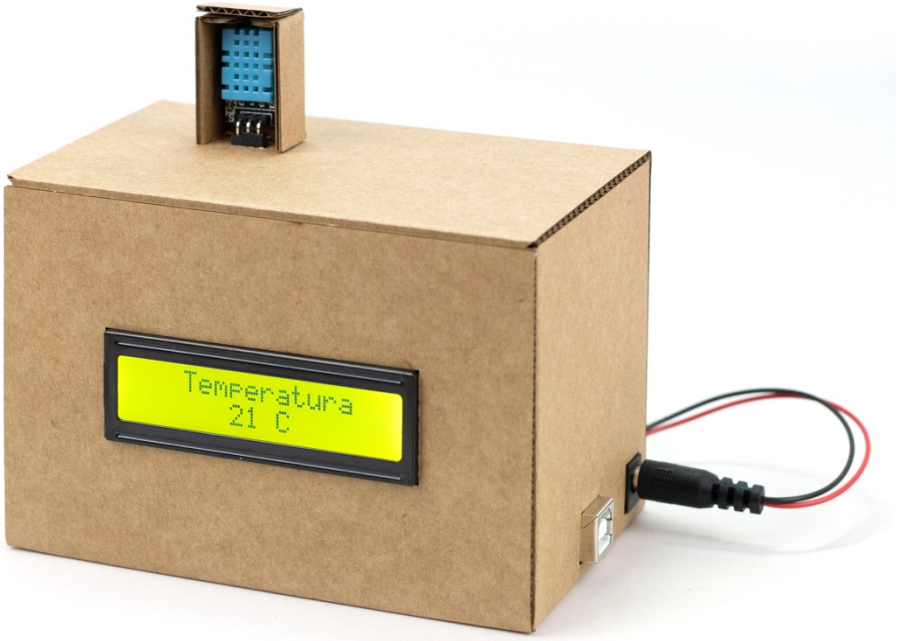
input makers

learning robotics



WEATHER STATION

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WEATHER STATION

1. Description of the project and its components.
   1.1. Arduino compatible board.
   1.2. Mini Breadboard.
   1.3. Temperature and relative humidity sensor.
   1.4. LCD screen with I2C adapter module.
2. Assembly of the project.
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3. Programming.

WEATHER STATION

Can you imagine building a weather station? Measure the temperature and relative humidity of your house understanding the operation and the reason for each of its components?

With the Inputmakers Weather Station you will make it happen. You will expand your knowledge of robotics and programming by understanding each instruction of the program and most importantly, you are going to have fun doing it!

With the Inputmakers Weather Station you will learn about:

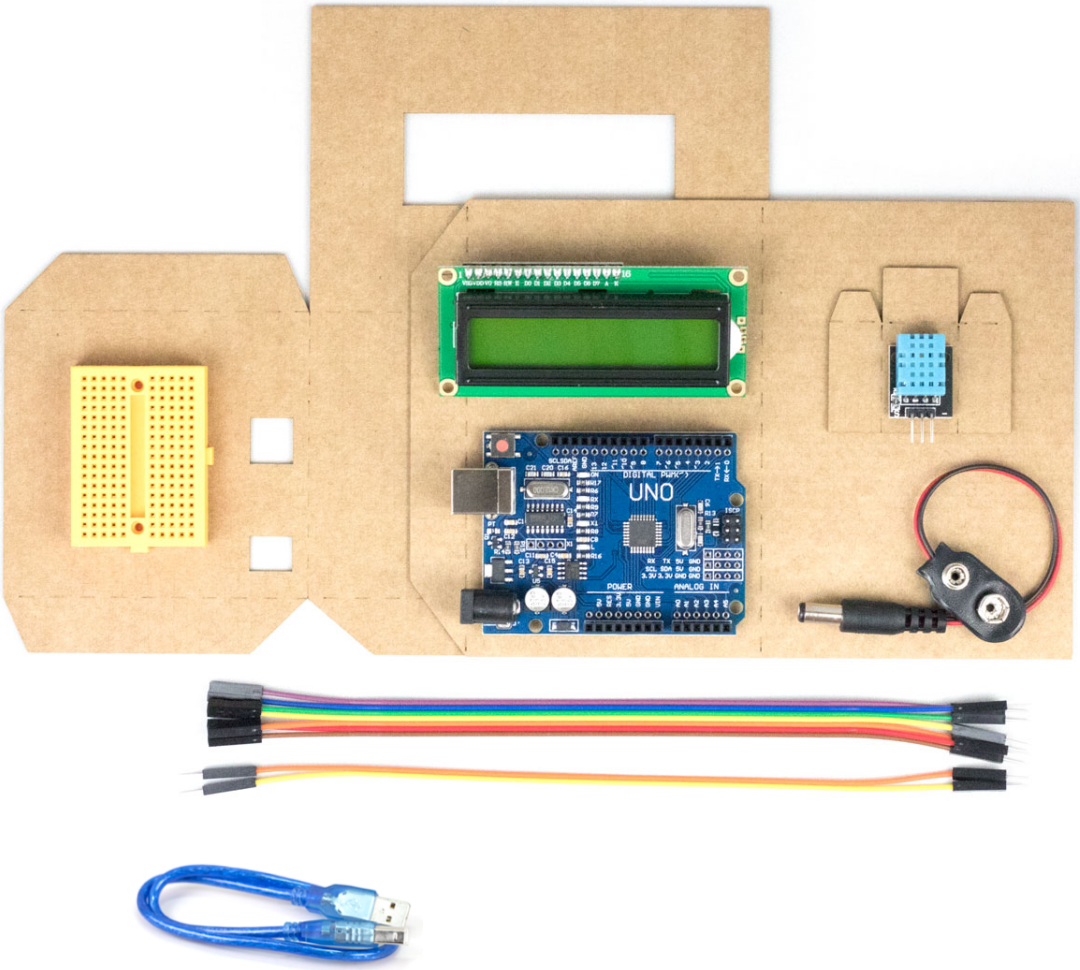
- The Arduino compatible board.
- The mini breadboard.
- The Model DHT11 temperature and relative humidity sensor.
- The LCD screen with I2C Adapter module.
- Circuit assembly.
- Programming.

1. DESCRIPTION OF THE PROJECT AND ITS COMPONENTS:

The weather station is a robotics project that serves to measure the temperature and relative humidity of the environment. A sensor measures this data, the Arduino compatible board processes it and it is displayed on the screen in real time.

The InputMakers weather station is made up of:

- Arduino compatible board with USB cable.
- Mini breadboard.
- Male-male (2 units) and male-female (7 units) connection cables.
- DHT11 sensor.
- LCD screen with I2C module.
- 9V battery.
- Battery connector.
- Cardboard pieces.


UNO
POWER
ANALOG IN

1.1. THE ARDUINO COMPATIBLE BOARD:

It is like a small computer that receives information from different sensors. These sensors can be different and very varied, for example: temperature and humidity, sound, buttons, limit switches, etc.

After executing a program with a series of commands, we will send the output signals to control different devices, for example: a led, a motor, a buzzer, displaying information on a screen ...

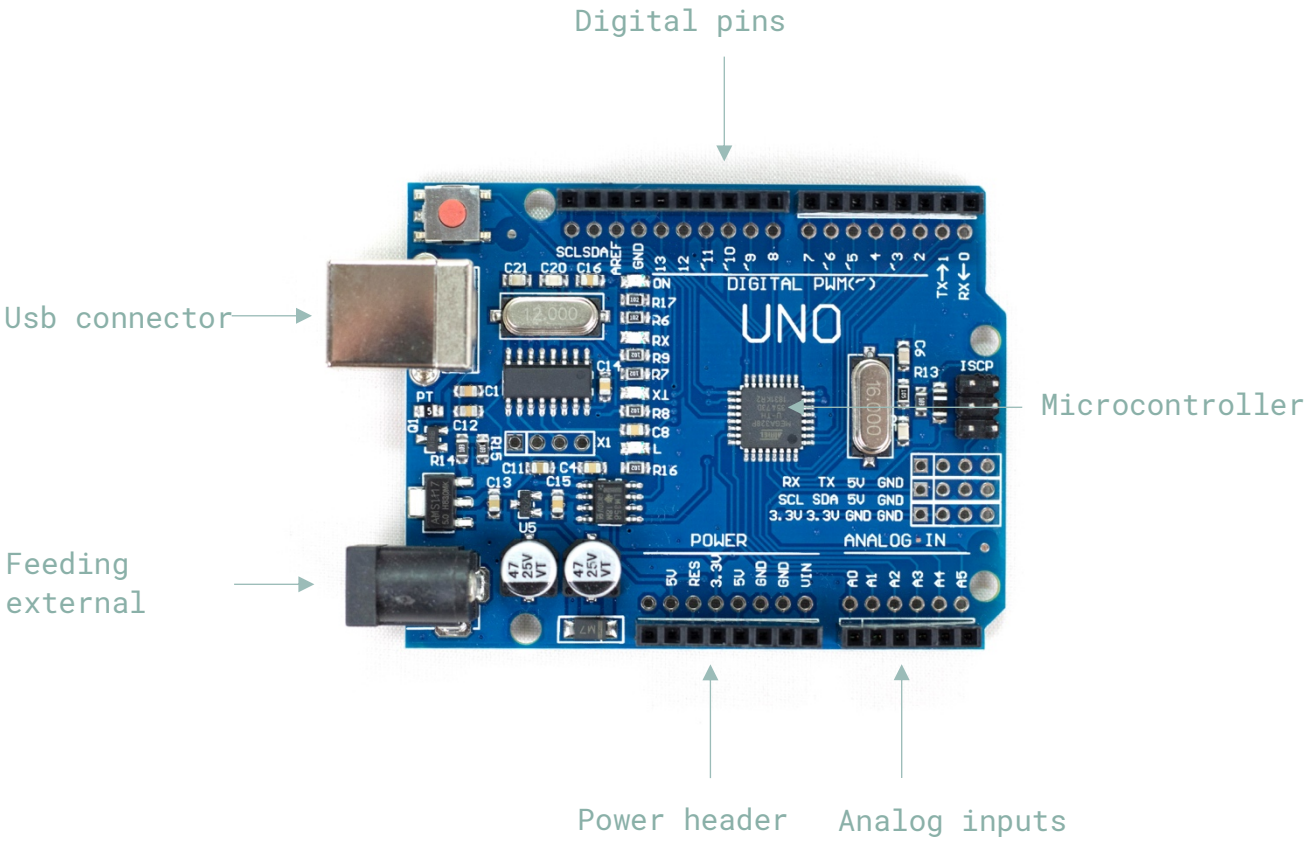
This plate is made up of:

- A microcontroller.
- Digital pins: 14 digital inputs / outputs that we will call pins.

Each of these pins can be configured as an input or an output. Only the 6 with the ~ symbol can be used as PWM (Pulse Width Modulation) outputs.

Within the digital pins we can find the RX SERIAL IN pin (reception) in position 0 and the TX SERIAL OUT pin (transmission) in position 1.

- 6 analog inputs: pins intended to read analog signals.
- Power header.
- External power connector: accepts voltages between 7 and 12V,
- USB connector (5V).

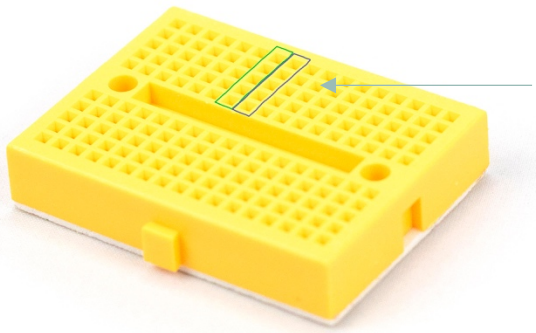


1.2. MINI PROTOBOARD PLATE:

It is a flat plastic component with holes connected by rows. It is used to assemble electronic circuits without having to solder their components, this creates a work environment where we can test, assemble and disassemble components and circuits as many times as we want.

In our case we use the mini breadboard due to the reduced space we have in our project.

We can divide the breadboard into two identical areas separated by a central groove. In each area, the holes in each of the rows are electrically connected to each other. However, each row is electrically isolated from the others, as explained below.

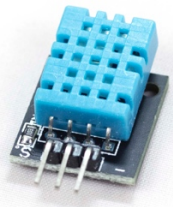


THE HOLES IN THE GREEN COLUMN ARE ELECTRICALLY CONNECTED TO EACH OTHER, BUT ISOLATED FROM ANY OTHER, FOR EXAMPLE, THE BLUE.

We will use the mini breadboard to make the different connections to the negative and positive of the circuit.

1.3. TEMPERATURE AND RELATIVE HUMIDITY SENSOR:

It is the component or input device that allows us to measure temperature and relative humidity.



The DHT11 sensor will provide us with the digital input signal. Its main characteristics are:

Temperature measurement	From 0ºC to 50ºC (± 2ºC to 25ºC)
Relative humidity measurement	Measures between 20% and 80% (± 5ºC between 0ºC and 50ºC)
Feeding	Between 3.5V - 5V

Regarding the entrance:
We know that temperature and humidity are physical quantities and therefore analog signals, however, the DHT11 sensor will convert from analog to digital and consequently we will read a digital signal. The transformation is done as follows: the data frame to transmit the information is 40 bits ordered as follows:

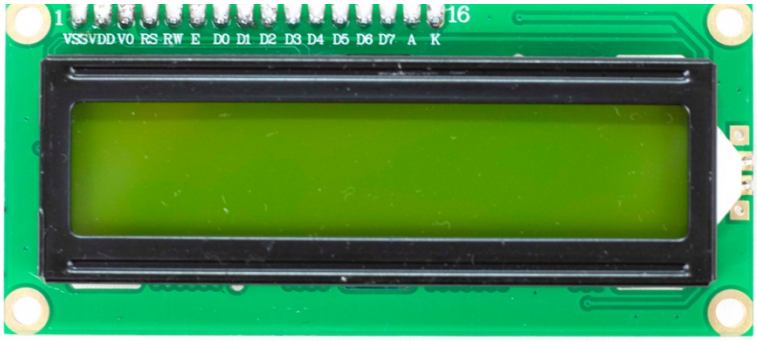
- First group of 8 bits: corresponds to the integer part of the temperature.
- Second group of 8 bits: corresponds to the decimal part of the temperature.
- Third group of 8 bits: corresponds to the integer part of the relative humidity.
- Fourth group of 8 bits: corresponds to the decimal part of the relative humidity.
- Fifth group of 8 bits: the so-called parity bits. They are used to confirm that there is no corrupted data. (It is verified that the sum of the first 4 groups gives as a result the parity bits).

- Example :
  - Temperature: 40.5 ° C
  - Relative humidity: 26.8%

8 bits of temperature (integer part)		8 temperature bits (decimal part)		8 bits relative humidity (integer part)		8 bits relative humidity (decimal part)		8 bits of parity
↓		↓		↓		↓		↓
0101000	+	00000101	+	00011010	+	00001000	=	01001111
40	+	5	+	26	+	8	=	79

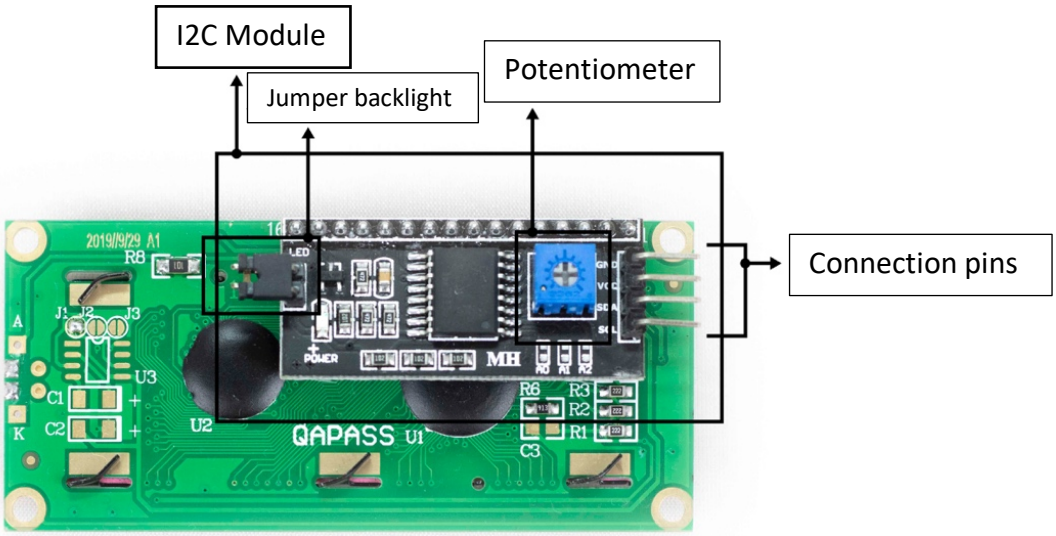
1.4. LCD DISPLAY WITH I2C ADAPTER MODULE:

It is the component or output device that allows us to read the temperature and relative humidity information. To facilitate communication and connection of our Arduino compatible board with the LCD screen, we use the I2C adapter module. In our case, both elements are already soldered.



In the I2C module we can find:

- Jumper backlight: allows you to darken the screen or leave it with the green background color.
- A potentiometer to adjust the contrast of the display.
- The connection pins: Vcc (5 V), GND, SDA and SCL.



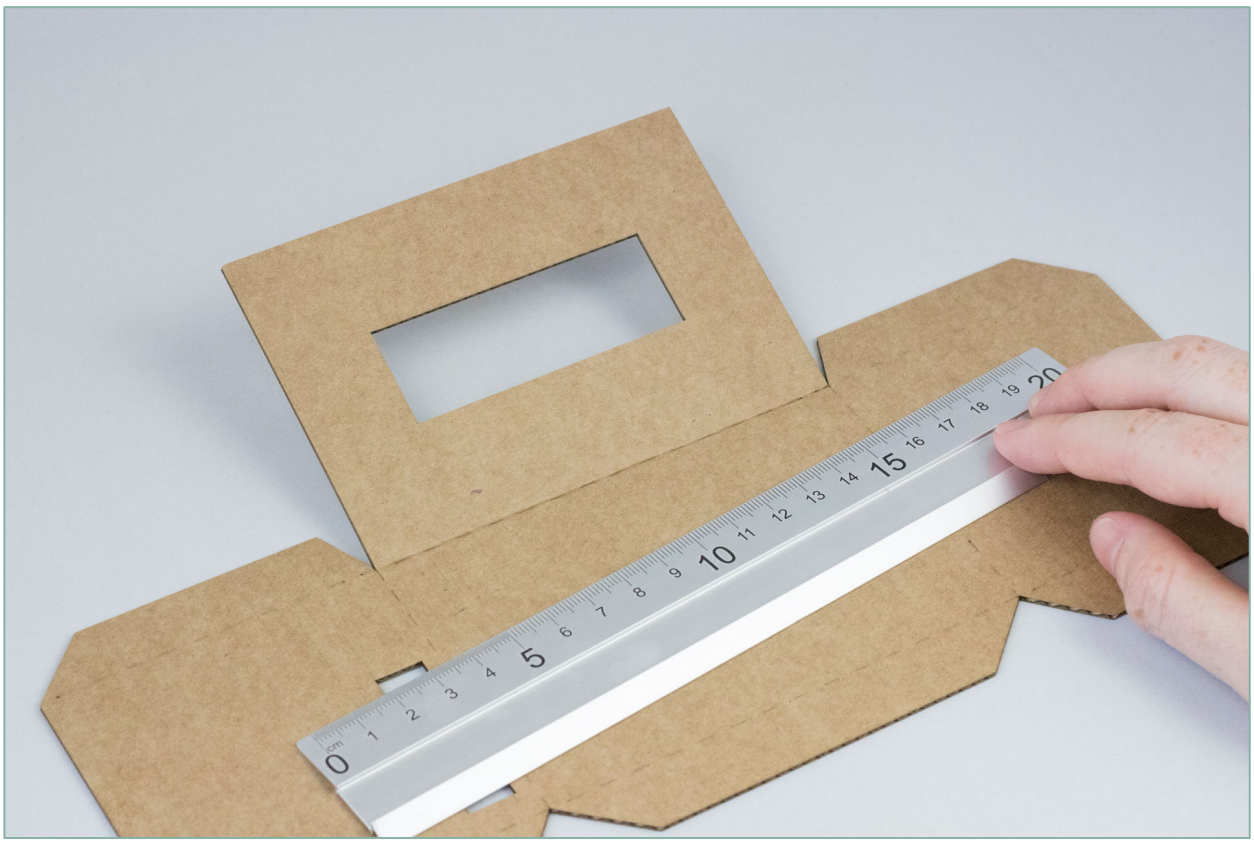
Regarding the output: The output will also be digital as we are showing a series of values on the LCD screen using the I2C protocol (2-wire control bus, SDA for data and SCL that controls the clock).

2. PROJECT ASSEMBLY:

2.1. ASSEMBLING:

* It is recommended to use hot silicone to glue the different parts of the project.

a) The pieces of the project have to be folded along the broken lines. We press with the edge of a ruler on that line and bend the piece.



b) We assemble the cardboard piece A. We glue the side flaps with hot silicone and / or white glue.

Cardboard piece A

Cardboard piece A

c) We glue the piece of cardboard B on the flaps of piece A. In this way we allow the lid to open and close comfortably. Attention! we want the box to be able to open and close. We will not glue all the flaps, only the indicated ones.

Cardboard piece B

d) LCD screen connection. Remember that the LCD screen already comes with the soldered I2C module, it showing the connections to be made:
(On page 12 you will find the diagram of all the connections, you can use it as a reference.)

I2C MODULE	CONNECTIONS ON THE BOARD OR THE MINI PROTOBOARD
GND (ground or negative pin)	GND negative row on mini breadboard
Vcc (pin for power)	5V positive row on mini breadboard
SDA (serial data: connection where the information is transmitted)	Analog pin 4 (A4) on the board
SCL (serial clock: defines the communication speed)	Analog pin 5 (A5) on the board

Manufacturers use two types of chip for the I2C module, your module may have the PCF8574T chip or the PCF8574AT chip, depending on the chip model it comes with one address or another. Make sure to put the correct address (the address that goes with your module) in the program.

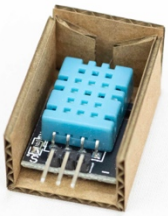
CHIP PFC8574	ADDRESS (ADDRESS)
PFC8574T	0x27
PFC8574AT	0x3f

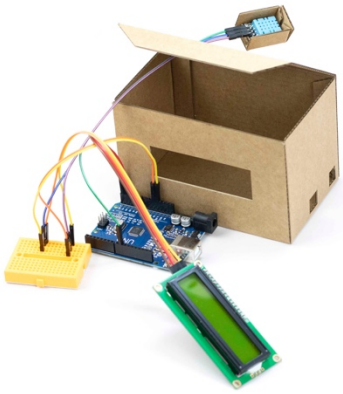
e) DHT11 sensor connection:

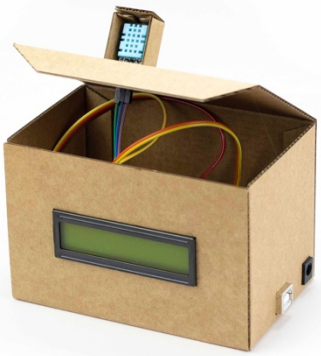
We pass the cables that go to the DHT11 temperature sensor through the hole in the cover and connect them to the sensor. The DHT11 sensor has three connection pins available, they will connect:

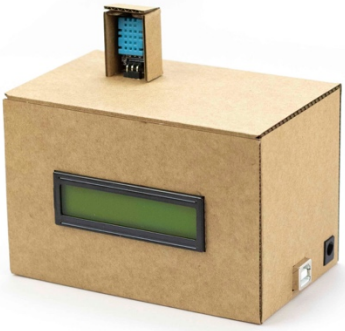
DHT11 SENSOR	CONNECTIONS ON THE BOARD OR THE MINI PROTOBOARD
Pin marked S (signal)	Digital pin number 9 on the board (He will read the sign).
Pin marked with negative sign (-)	GND negative row on mini breadboard
Unmarked center pin. (It corresponds to positive)	5V positive row on mini breadboard

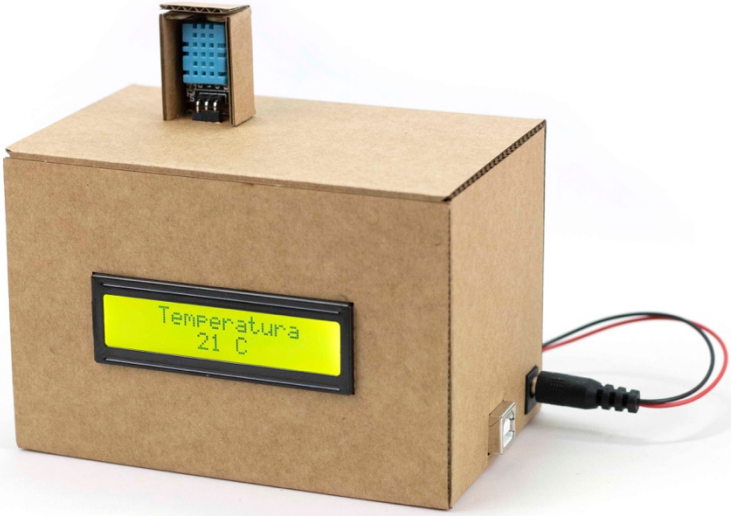
f) Mount the cardboard piece C on top of the box. This will help us protect the DHT11 temperature sensor. Glue the DHT11 temperature sensor to part C with hot silicone so that it does not move. Finally, glue these pieces to the rest of the box that forms the weather station.



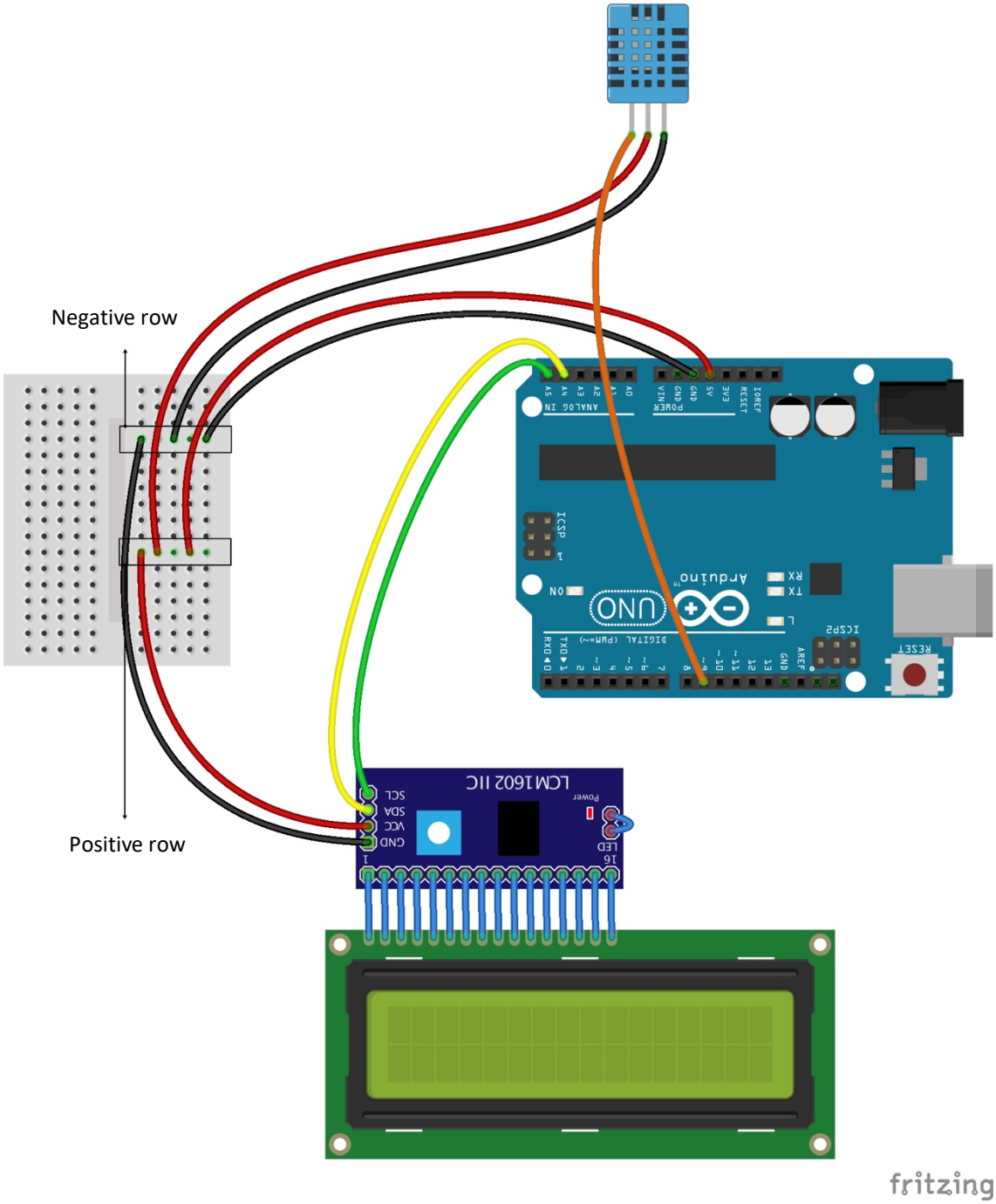







Temperatura
21 C

2.2. CIRCUIT MAP:



* All our schemes are designed with free software and open source fritzing (Fritzing is open source, free software). Said software uses recreations of original Arduino Uno boards in its schematics, in our kit we provide an Arduino compatible board.

Programming:

1. Download the Arduino IDE program (free software) from the official Arduino website and install it on your computer.

2. Once the program is correctly installed, we have to install different libraries for it to work correctly.

   But before that, what is a library? It is a code file that we incorporate into our program and allows us new functionalities.

   We will add:
   - the DHT.h library for the DHT11 sensor.
   - the Adafruit_Unified_Sensor library since it is a dependency of the DHT library.
   - the NewLiquidCrystal library for the LCD screen with the I2C module.

   This will allow us to make these components work.

   How do we add them?

   For the DHT.h library
   - Go to: Tools> Manage libraries
   - The Libraries Manager will appear.
   - We type in the search “DHT sensor library”. We look for it and proceed to install it. It is possible that a dialog box will appear asking us for permission to install other necessary related libraries, in that case, we will install everything (Install all).

   For the Adafruit_Unified_Sensor library
   - Go to: Tools> Manage Libraries
   - The Library Manager will appear.
   - We type in the search “Adafruit_Unified_Sensor”. We find it and proceed to install it.

   For the NewLiquidCrystal library it is not possible to add it using the Library Manager and therefore it must be installed manually.
   For this we can go to the link:

   https://github.com/fmalpartida/New-LiquidCrystal

   And we download it by displaying the green button (code)> Download ZIP

   We will download a file in .zip format to the download folder of our computer. Then we unzip this file, a new folder will be generated that contains the different files that make up the library. We copy this folder and paste it into the "libraries" folder inside the "Arduino" folder.

   Done, it's already installed!

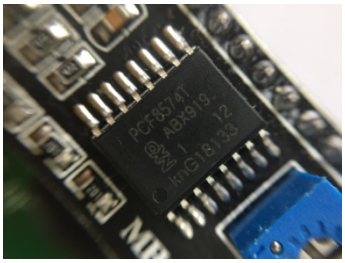
3. Connect the board to the computer with the USB cable.

4. Check that we have selected the model of the Arduino / Genuino Uno board.
   Go to: Tools> Board: "Arduino / Genuino Uno"

   The board is connected by default, but it is important to check that it is selected correctly. If not, the program will not work for us.

5. Check that the board is connected to the USB port.Tools> Port: usbserial (it connects by default).

6. Check that in the program you put the correct address corresponding to the chip model of your I2C module.
   - 0x27 if you have the PCF8574T model
   - 0x3f if you have the PCF8574A model



7. Write the programming code (pages 17 and 18) in the Arduino IDE.

   We recommend copying it by hand in order to better internalize what we are programming. If you forget to write a comma, parentheses, etc. it will give you a syntax error. Check this error in the line that the program tells you.

   If you decide to copy and paste the code, depending on the pdf reader it may not be copied correctly missing some programming line, if so you can always copy and paste the code in parts or complete by writing the part that is not pasted correctly.

   Even if you decide to copy and paste the program, try to understand each line of code, for this you have its explanation in the program.

   Everything to the right of // or between / * and * / is not executed by the program.

8. We press the VERIFY icon to verify that the program does not contain any errors in the code. If the verification is correct and we do not have

   no error, click on the UPLOAD icon.

Now we have the program uploaded to the plate, the temperature and relative humidity readings will appear on the LCD screen.
Adjust the display contrast with the potentiometer on the I2C module.

9. Once the program is uploaded to the board, we can disconnect it from the USB cable and feed it with the 9V battery.

Clarifications about programming in the Arduino IDE:
If you are not familiar with programming, do not worry, now we are going to give you a series of basic ideas from which you can begin to understand what this is all about.

There are different programming languages, some more similar to others, but let's say that the language used in Arduino is very similar to one of the types of languages most used in programming, the C ++ language.

It takes minutes for those who know how to program in C ++ to adapt to the Arduino IDE.

What you will find in the code of a program in the Arduino IDE are, in general terms, 3 parts:

1. The first part in which basically the necessary libraries will be included to execute the program and variables will be defined.
2. The second part, the void setup, here we define whether the Arduino pins are going to correspond to input or output variables (with the pinMode command) and we initialize system elements such as sensors, screens ...
3. The third part, the void loop, we implement the necessary commands for the program to do what we want.

Depending on the program and the programmer there may be variations.

On the next page you have the program.

Here is the program:

```
/ * InputMakers
Weather station.
Program to display on the LCD screen, the temperature and the relative humidity
through the DHT11 sensor.
Instructions:
Connect the signal pin of the DHT11 Sensor to digital input 9.
It is necessary to download the DHT library to be able to use this sensor.
Remember that we will use an LCD screen controlled by a Serial I2C Module
* /
#include <Wire.h> // We include the Wire.h library that establishes communication
with the I2C protocol.
#include <LiquidCrystal_I2C.h> // We include the library to use the LCD screen
with the I2C module.
LiquidCrystal_I2C lcd (0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Set the
address / connection of the LCD screen and the I2C module with the Arduino. If
it doesn't work, check these addresses: 0x3f (PCF8574AT chip) or 0x27 (PCF8574T
chip).
#include "DHT.h" // We include the DHT sensor library.
#define DHTPIN 9 // We define the digital pin where we connect the sensor, in
this case to digital pin 9.
#define DHTTYPE DHT11 // We define the type of sensor.
DHT dht (DHTPIN, DHTTYPE); // We initialize the DHT11 sensor.
void setup () {
lcd.begin (16,2); // We initialize the display with 16 characters and 2 lines.
dht.begin (); // We initialize the DHT sensor.
}
void loop () {
int h = dht.readHumidity (); // We define the integer variable h and read the
humidity.
int t = dht.readTemperature (); // We define the integer variable t and read the
temperature.

lcd.clear (); // Remove all symbols from the LCD.
lcd.setCursor (0,0); // Places the first letter in segment 0 of line 1 (It starts
counting from 0).
lcd.print ("Relative Humidity"); // Print Relative Humidity on the screen.
lcd.setCursor (6,1); // Position the first letter in segment 6 of line 2 (It
starts counting from 0).
lcd.print (h); // Print the humidity on the screen.
lcd.print ("%"); // Print% to screen.
delay (2500); // Pause the program 2.5 seconds.

lcd.clear (); // Remove all symbols from the LCD.
lcd.setCursor (3.0); // Position the first letter in segment 3 of line 1 (It
starts counting from 0).
lcd.print ("Temperature"); // Print Temperature on screen.
lcd.setCursor (6,1); // Position the first letter in segment 6 of line 2 (It
starts counting from 0).
lcd.print (t); // Print the temperature on the screen.
lcd.print ("C"); // Print on screen C.
delay (2500); // Pause the program 2.5 seconds.

lcd.clear (); // Remove all symbols from the LCD.
lcd.setCursor (0,0); // Places the first letter in segment 0 of line 1 (It starts
counting from 0).
lcd.print ("Readings:"); // Print Readings on screen.
```

```
delay (2500); // Pause the program 2.5 seconds.
}
```

Congratulations!! You have already built a Weather Station from scratch!

From the InputMakers team we want to congratulate you for giving you the opportunity to learn something new. We hope you had as much fun assembling your WEATHER STATION as we did when preparing it.

Most important concepts you have learned are:

- The Arduino compatible board.
- The mini breadboard.
- The Model DHT11 temperature and relative humidity sensor.
- The LCD screen with I2C Adapter module.
- Analog inputs.
- Circuit assembly.
- Programming in the Arduino IDE.

Greetings from the InputMakers team and keep learning!

* The circuit diagrams and figures made with free and open source fritzing software (Fritzing is open source, free software) are licensed under Creative Commons Attribution Share Alike CC By-SA. The rest of the manual is all rights reserved.