

LEVEL 4 ASSESSMENT SPECIFICATION

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Programme:	HNC Electrical/Electronic Engineering & Instrumentation Engineering		
Module:	Embedded Systems		
Module code:	PCEE4004	Contribution to Overall Module Assessment (%):	100%
Lecturer:	Sarah Williams	Internal Verifier:	Jason Pointer
Assignment Title:	Office Environment Monitor	Word count (or equivalent):	2000 words
Submission deadline:	12 th May 2023	Return date of provisional marks & written feedback:	10 th June 2023
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

1. Demonstrate a good understanding of the fundamental principles of programming an embedded system.
2. Describe the basic elements of typical embedded hardware and apply that knowledge in the analysis of a number of simple system applications.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
	0	
2. Knowledge and Understanding Skills		
Hardware Has exhibited for the most part a good knowledge of the basic underlying concepts and principles. You have included a description of the components used and justified why you have used them. Other components were considered and you have explained why these were not used. The discussion about using a servo motor is a good idea of how you could have used the device in an original way. The dial could just have 3 sections, too hot, too cold and ok, and smaller intermediate values need not be shown, however the placement of the needle may suggest if the temperature is close to a boundary. Circuit schematic has been provided, be careful to include wires to all components in the circuit. 7.5/15 Software Competent knowledge of the basic underlying concepts and principles. Flowchart provided uses correct symbols appropriately and logically describes how the system will work. Further marks here would have been gained by including pseudocode. 9/15	30	16.5
3. Cognitive and Intellectual Skills		
Discussion, Evaluation and Conclusion Good evaluation of the underlying concepts and principles. Mostly valid arguments and logical judgements. You have considered the usefulness of the C language when working with embedded systems and have referenced your sources. There are limited but valid suggestions as to how the system might be improved, and you have considered how effective your solution is. 8/15	15	8
4. Practical Application Skills		
Implementation A good and appropriate application of basic methods, suitable method of implementation used.	50	29

Program is functional and meets the requirements of the assignment. It is convention to bring in libraries first, then global functions, then declare constants, global variables together in groups. This makes it easier for someone to debug a program as the libraries are together, the constants are together etc. Serial begin only needs to be done once. As you are not really using the serial monitor for anything other than testing, it does not really need to be included at all, so consider commenting it and the serial print commands out when the system is actually being deployed and not tested. Code is well commented, but you only need // at the start of the comments and not at the end - use /* comment here */ where you have several lines to comment together. You have used good practice by selecting appropriate constant names for your pins. Indentation was on the whole correct, although not perfect. **23/40**

Testing

A very good application of basic techniques for testing. Testing covers the main states of the system, and it looks like you started considering boundary values. The testing table should include specific values at the boundaries of where the state of the system changes to ensure complete correctness. **6/10**

5. Transferable Skills for Life and Professional Practice

Work is coherent, very fluent and is presented professionally. Can work effectively independently.

Work is set out formally, well structured, including contents page, referenced statements where required and labelled diagrams. **4/5**

5

4

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

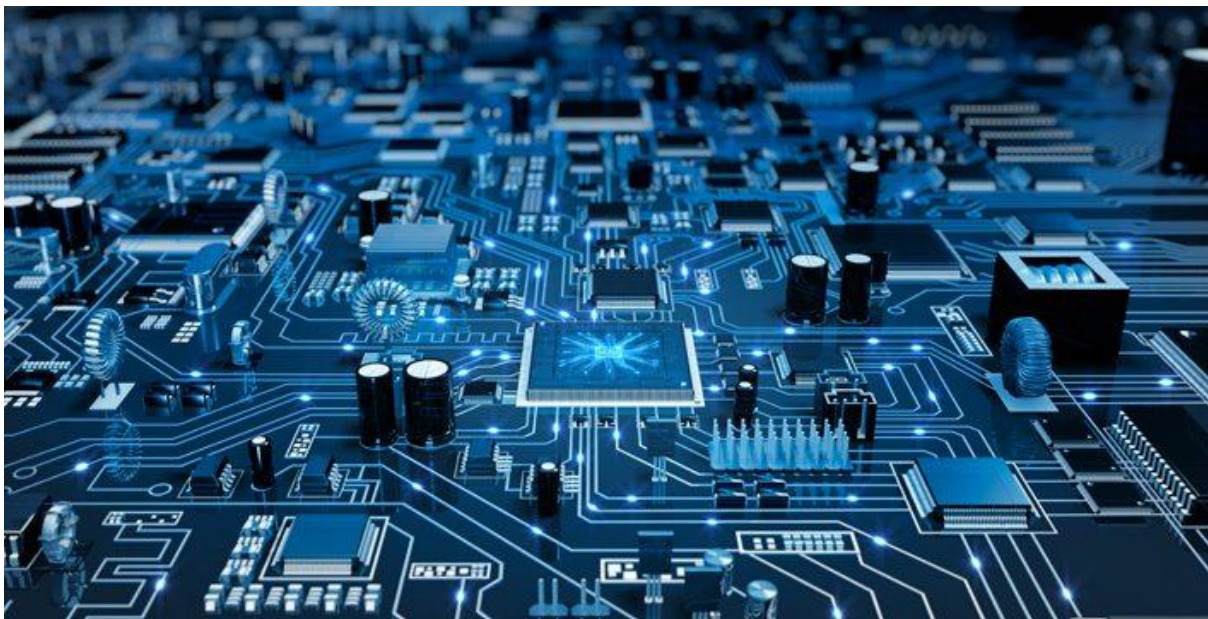
57.5%

Assignment 1: Embedded Systems

Assignment Title: Office Environment Monitor

Programme: HNC Electrical and Electronic Engineering

Lecturer: Sarah Williams



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Introduction-

The report is based on concerns raised within the workplace about the effectiveness of the heating and air conditioning system. In the report a simple device has been produced to report if the environment is outside of comfortable working conditions.

The UK government have a guidance which suggest the workplace room temperature to be *“a minimum of 16°C or 13°C if the employees are doing physical work.”* (GOV.UK, 2023)

The recommended working temperature for offices and dining rooms is 20°C and accepted that people usually work best at the temperatures between 16 °C and 24 °C stated by the chartered institute of building services engineers.

Trade unions have pushed for the *“legal maximum temperatures for indoor work of 30°C (27°C for those doing strenuous work).”* (TUC, 2023)

The report is an office environment monitor which will indicate when the working condition is not within the acceptable ranges. From the carried-out research the decided range for the acceptable temperature will be between 16 and 24°C. The device will contain an LCD to state the present temperature within the room and an RGB LED will report a specific colour dependent on the room environment. If the room is too warm it will emit Red, if it's too cold it will emit Blue and if its within the comfortable environment range it will emit Green. The workplace environment is important to keep workers at a comfortable working temperature following the health and safety at work law.

Task 1- Hardware Design

The office environment monitor will function by an input temperature sensor which will output on a screen and emit a specific colour to show the user if the work room is within the acceptable range. The Orange pi Kona328 is an Arduino UNO compatible development board shown in figures 10-12 in the appendix. The *“Arduino is an open source electronics platform based on easy-to-use hardware and software”* (ARDUINO, 2023).

The board is used to read inputs and turn the input to an output. The board can be told what to do with the inputs and outputs by sending a set of instructions from an Arduino programming language. The purpose used for the Orange pi Kona328 is to take the room temperature as an input and use that with the coding to give an output on the RGB LED and the LCD. This is done by using the input and output pins on the board. The Orange pi Kona328 was chosen because it is a simple and accessible device to use as a beginner. It was also chosen due to the low cost compared to others.

The RGB LED consists of three different colours which are Red, Green and Blue. The datasheet for the RGB is shown in the appendix figures 13-16. The function of the RGB LED used in the microcontroller system is to show a colour dependant on the workplace room temperature. The purpose of this component is to state whether the room is too hot, too cold or at a comfortable working condition. For example, this is done by using the RGB colour with each colour having a different meaning. Firstly, if the LED shows red it means that the room temperature is above 24 °C meaning it's too warm. Whereas if the LED shows blue then the room temperature is below 16 °C and therefore is too cold. Lastly if the LED shows green then the room is within the comfortable working conditions of between 16-24 °C. The RGB was chosen in the system so the user can see from a distance if the room is too cold, good or too hot. The RGB was chosen because it can show 3 different colours.

Originally the device was going to use 3 different colour LEDs but this would have involved more wiring and coding. After carrying out research the RGB was a great choice to show the room condition reducing the amount of wiring needed and reducing the need for 3 LEDs to only 1.

Another component considered to allow the user to know what condition the room is in was to use a buzzer. This could have been done by coding the buzzer to buzz when the temperature was either $<16^{\circ}\text{C}$ or $>24^{\circ}\text{C}$. When the buzzer would activate this would allow the user to know the room temperature is not within the comfortable working conditions. The reason the buzzer was not chosen was because if the user was not within the room when it activates then nobody would know when they enter the room again. Whereas the LED stays on continuously so the user would know whenever they are within the room. Also, with the buzzer you can't tell if its activated due to it being too hot or too cold whereas the LED colour states the condition. Lastly the buzzer could be coded to stay on until the room temperature is back to comfortable condition but that could take a while and the buzzer would be annoying and distracting whilst working waiting for the room temperature to get back to the comfortable conditions.

The liquid crystal display (LCD) will be used as a simple device to display the current temperature of the room. The LCD datasheet can be seen in the appendix figure 17. The 16 by 2 display screen is used in the system to show the temperature in degrees on the top row and the temperature in Fahrenheit on the bottom row. The purpose of the LCD is to show the current room temperature so the user can know the current temperature of the room and whether or not to adjust the heating. This allows the user to keep the room temperature at comfortable conditions.

The other component considered to display the room temperature was a servo motor which moves on a rotation arc of $0-180^{\circ}$. This could have been coded so that for every 1°C the servo meter moves 6° . This means that the servo meter could show from the range of $0-30^{\circ}\text{C}$ by using that ratio. A display could have been made for the outside of the servo motor so that for every 6° the temperature would display 1°C more. The reason the LCD was chosen over this is that the LCD is easier to read and easier to clarify the exact room temperature reading.

A DHT11 will be used in the system as a temperature sensor. The DHT11 datasheet can be seen in figure 18-20 in the appendix. The DHT sensor is used to measure the room temperature in the workplace and to output the values as data to display on the LCD mentioned above. The DHT11 sensor functions by a mounted NTC temperature sensor which is built into the unit. The DHT11 uses a signal wire to transit the data to the Arduino which is then coded to display on the LCD.

Office Environment Monitor

Schematic drawing

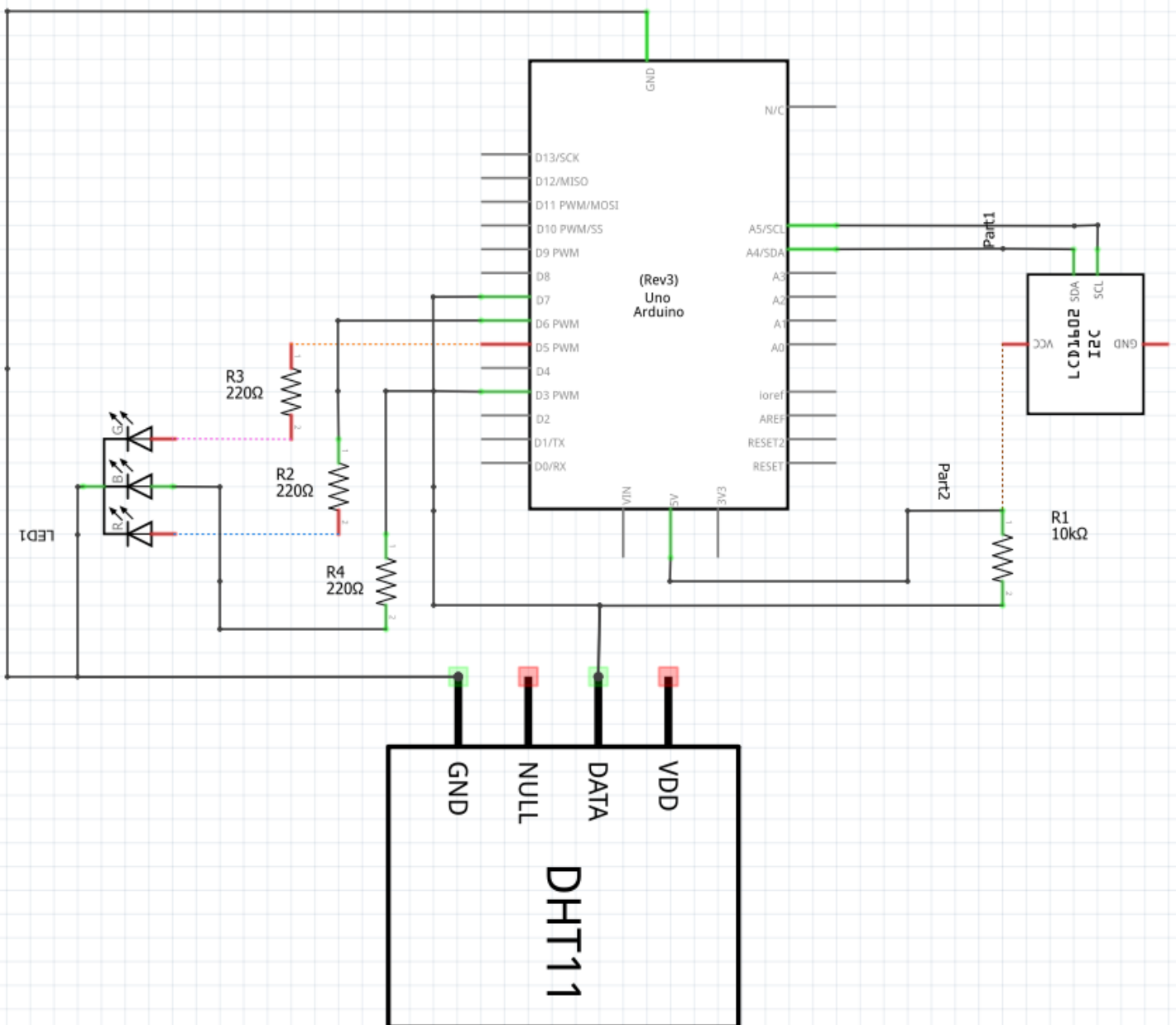


Figure 1- Microcontroller System Schematic Drawing
Accessed on 03/05/23

Microcontroller System Diagram

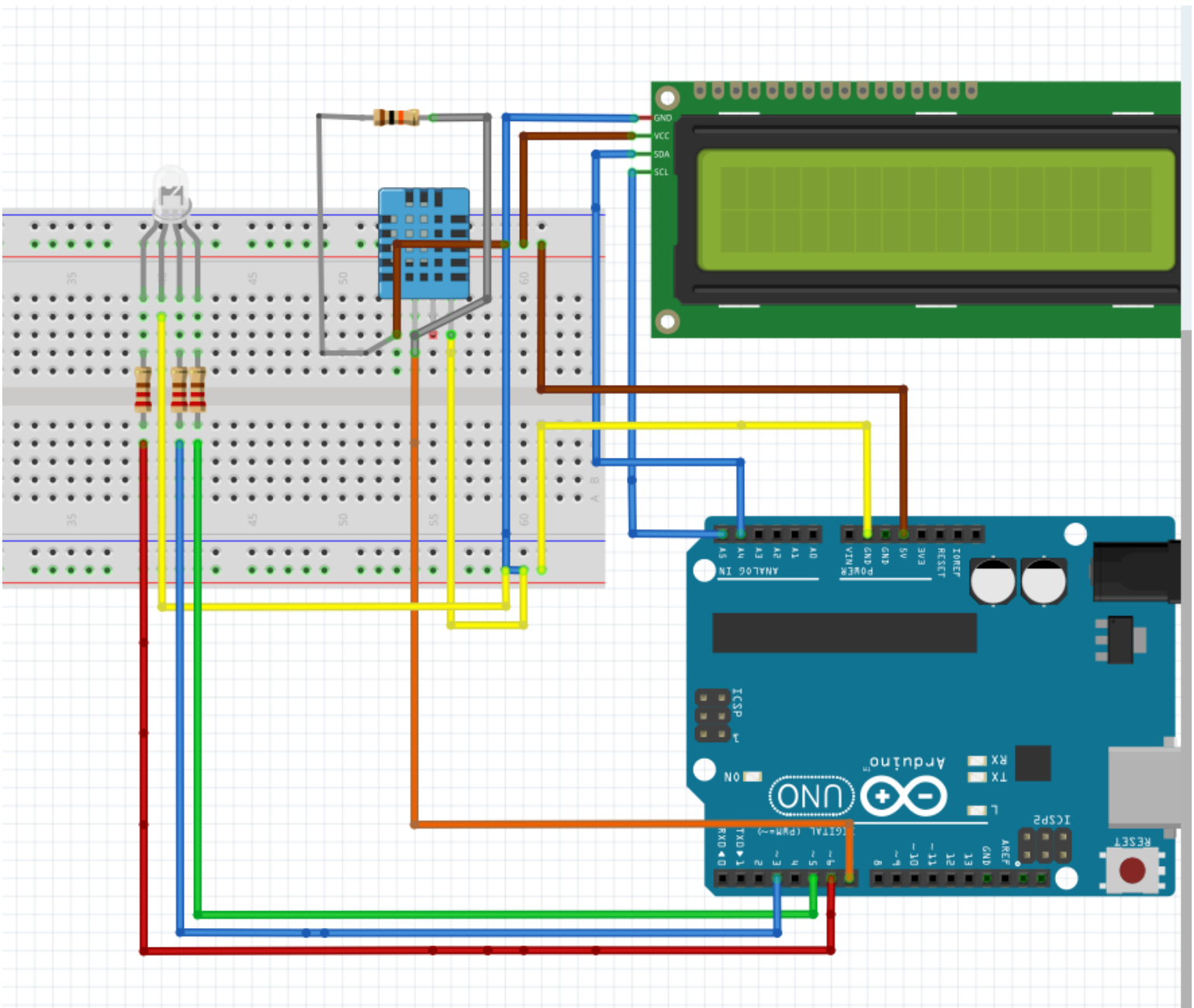


Figure 2- Microcontroller System Diagram
Accessed on 04/05/2023

Task 2- Software Design

From the research carried out above in the introduction the chosen range for the acceptable working conditions are from 16-24 °C. The device will monitor the environment within the workplace and will report back if the temperature is not within the acceptable range stated above. The flowchart for the design of the program can be seen in figure 3 below.

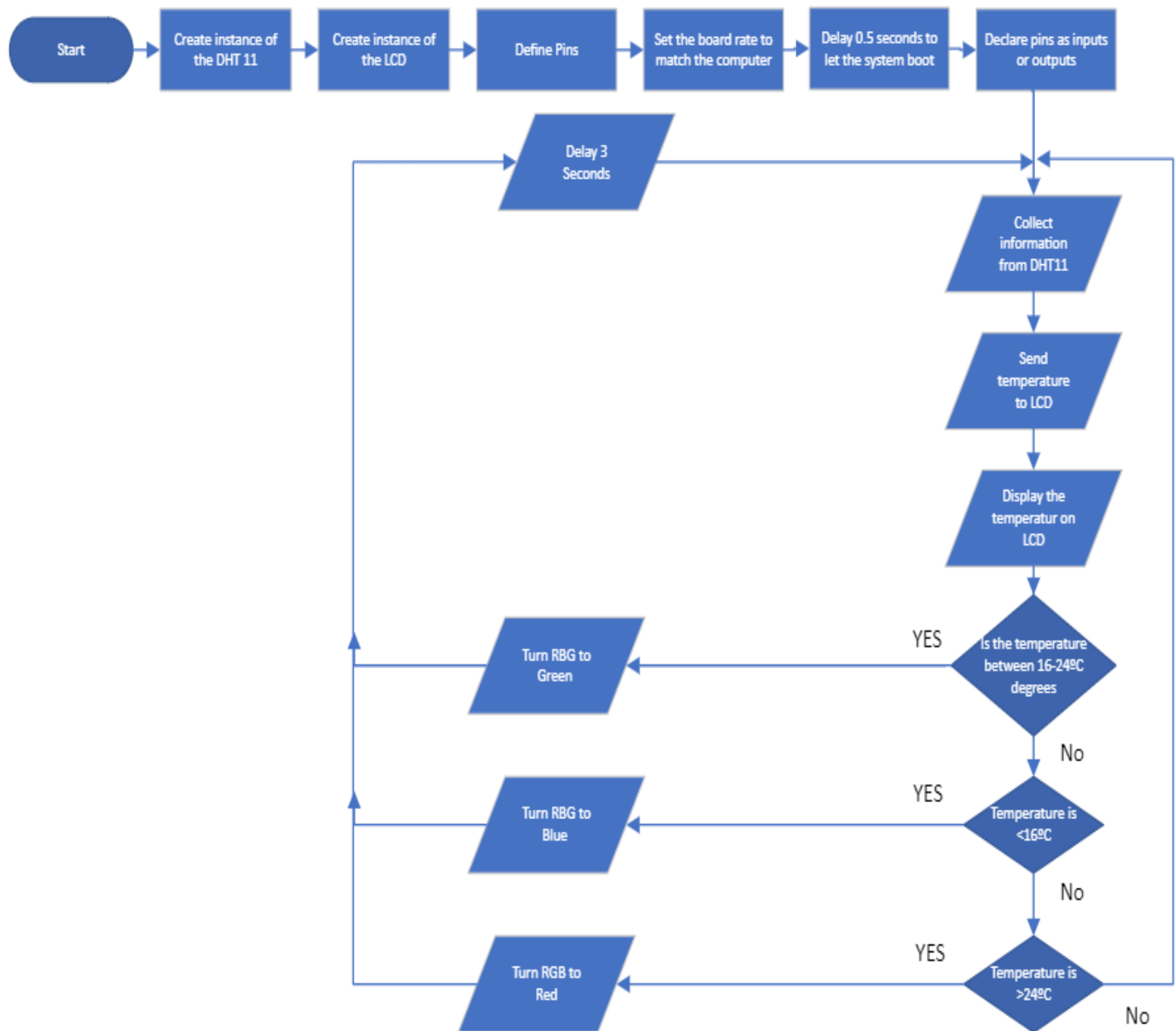


Figure 3- Program Design Flowchart
Accessed on 03/05/23

Task 3-Implementation

Office environment Monitor Code with Clear comments

Task 3- Implementation

```
#include "DHT.h" //Bringing in the library//
#define DHT11_PIN 7 //Dedicating pin 7 to DHT//

#define RED_LED 6 //Dedicating pin 6 to RED_LED//
#define GREEN_LED 5 //Dedicating pin 5 to GREEN_LED//
#define BLUE_LED 3 //Dedicating pin 3 to BLUE_LED//

DHT tempSensor(DHT11_PIN,DHT11);

#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2); //Bringing the LCD library in//

void setup() {
  Serial.begin(9600); //To send data at the same speed as the computer//
  delay(500); //Delay to let the system boot//
  Serial.println("DHT11 Humidity & temperature Sensor\n\n"); //To see the data loading
  on the monitor//
  delay(1000); //Wait 1 second before accessing sensor//
  tempSensor.begin(); //Start the temp sensor//

  Serial.begin(9600); //to send data at the same speed as the computer//
  lcd.begin (16,2); //Define the LCD as 16 column by 2 rows//
  lcd.init();
  lcd.backlight();
  lcd.clear(); //LCD screen to clear//
  lcd.setCursor(0,0); // Setting cursor to start at 0,0//

  pinMode(RED_LED, OUTPUT); //Declaring RED_LED as an output//
  pinMode(BLUE_LED, OUTPUT); //Declaring BLUE_LED as an output//
  pinMode(GREEN_LED, OUTPUT); //Declaring GREEN_LED as an output//
}
```

```

void loop() {

float temp=tempSensor.readTemperature(); //Used to convert the degrees to
fahrenheit//
float tempf; //Define the fahrenheit float variable//
Serial.print("temperature="); //Testing to see if the readings are correct//
Serial.print(temp); //Testing to see if it shows on the serial print//
Serial.println("C");//Testing to see if it shows on the serial print//

lcd.print("temp="); //LCD to print temp=//
lcd.print(temp);//LCD to print the temp//
lcd.print("C"); //LCD to print "C"//

tempf=(temp*1.8)+32; //converting from Celsius to Fahrenheit//
lcd.setCursor(0,1); //move cursor to position 8 on row 1//
Serial.print("temperature="); //Testing to see if the readings are correct//
Serial.print(tempf); //Testing to see if it shows on the serial print//
Serial.println("F");//Testing to see if it shows on the serial print//

lcd.print("temp=");//LCD to print temp=//
lcd.print(tempf); //LCD to print temp=f//
lcd.print("F");//LCD to print "F"//

//lcd.print(temp); //print the temperature in Celsius//
lcd.setCursor(8,1); //move the cursor to position 8 on row 2//
delay(5000); //delay the temp output for 5 seconds//
lcd.clear(); // Clear the LCD screen//

if(temp>=16&&temp<=24){
  analogWrite(GREEN_LED, 255); //If the temperature is between 16 and 24 degrees
the green led will be on//
  analogWrite(BLUE_LED, 0); //If the temperature is between 16 and 24 degrees the
blue led will be off//
}
}

```

```
    analogWrite(RED_LED, 0); //If the temperature is between 16 and 24 degrees the
red led will be off//
}
else if (temp<16){
    analogWrite(BLUE_LED, 255); //If the temperature is less than 16 degrees the blue
led will be on//
    analogWrite(GREEN_LED, 0); //If the temperature is less than 16 degrees the green
led will stay off//
    analogWrite(RED_LED, 0); //If the temperature is less than 16 degrees the red led
will stay off//
}
else if (temp>24){
    analogWrite(RED_LED, 255); //If the temperature is greater than 24 degrees the
red led will be on//
    analogWrite(BLUE_LED, 0); //If the temperature is greater than 24 degrees the blue
led will stay off//
    analogWrite(GREEN_LED, 0); //If the temperature is greater than 24 degrees the
Green led will stay off//
}
delay(3000); //wait 3 seconds before accessing sensor again//
}
```

Task 4- Testing

Test#	Testing	Expected	Actual	Issues
1	The Temperature in the room shown on the LCD is correct	"24.1°C" on LCD	LCD showing 24°C	None as it was compared to a thermo sensor and temperatures were similar.
2	RGB changes to the correct colour when the environment changes within the room	The RGB LED to change from green to either red or blue dependent on if it's too cold or too warm	RGB LED was showing both colours at the same time	The RGB LED wasn't clearing the last colour so both colours were on show
3	Temperature below 16°C RGB turns Blue	RGB LED to turn Blue	RGB LED emitting Blue	None
4	RGB turns Red when the temperature goes above 24°C	RGB to turn Red	RGB LED emitting Red	None
5	RGB to be Green when temperature is between 16-24 °C	RGB to turn Green	RGB LED emitting Green	None

Test 1



Figure 4- Comparing LCD temperature reading with a calibrated thermo sensor
Accessed on 05/05/2023.

Test 1 was carried out to see that the DHT11 temperature sensor worked as the input whilst outputting the correct temperature on the LCD. As shown in figure 4 the LCD output temperature reading has been compared to the calibrated thermo sensor. The reading on the LCD is within 0.1°C which is an acceptable tolerance. This was an important test as its crucial that the temperature sensor input is correct as this controls the outputs to allow the user to know if the room is within the comfortable working environment.

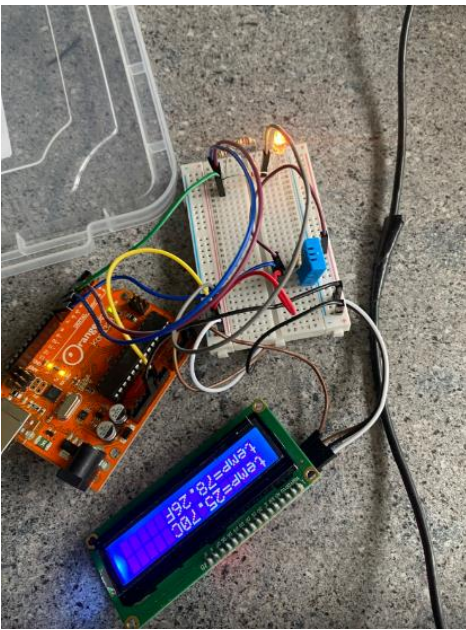
Test 2

Figure 5- RGB LED showing green and red resulting in the colour orange.
Accessed on 05/05/2023.

After carrying out a test changing the temperature using a heat gun it was found that when the environment of the room changed the LED colour would come on such as red for too warm but the green also stayed on which was the previous room condition when it was within the comfortable condition. Because of the Green and Red both being on this gave off an orange colour as shown in figure 5. This meant that when the room condition changed the previous condition showing on the LED wouldn't clear. This meant before carrying out more tests the code needed to be updated. This issue was fixed by adding the code that when the LED for example is Green the temperature is between 16-24°C so the Blue and Red LED need to be at 0 so it can't be on when its shining green. This

code was added to each colour so that when one colour is on the others are off. The code for this can be seen below in figure 6.

```
//RGB code//
if(temp>=16&&temp<=24){
  analogWrite(GREEN_LED, 255); //If the temperature is between 16 and 24 degrees the green led will be on//
  analogWrite(BLUE_LED, 0); //If the temperature is between 16 and 24 degrees the blue led will be off//
  analogWrite(RED_LED, 0); //If the temperature is between 16 and 24 degrees the red led will be off//
}
else if (temp<16){
  analogWrite(BLUE_LED, 255); //If the temperature is less than 16 degrees the blue led will be on//
  analogWrite(GREEN_LED, 0); //If the temperature is less than 16 degrees the green led will stay off//
  analogWrite(RED_LED, 0); //If the temperature is less than 16 degrees the red led will stay off//
}
else if (temp>24){
  analogWrite(RED_LED, 255); //If the temperature is greater than 24 degrees the red led will be on//
  analogWrite(BLUE_LED, 0); //If the temperature is greater than 24 degrees the blue led will stay off//
  analogWrite(GREEN_LED, 0); //If the temperature is greater than 24 degrees the Green led will stay off//
}
delay(3000); //wait 3 seconds before accessing sesnor again
}
```

Figure 6- New code to correct the issue of showing more than 1 colour
Accessed on 05/05/2023.

Test 3

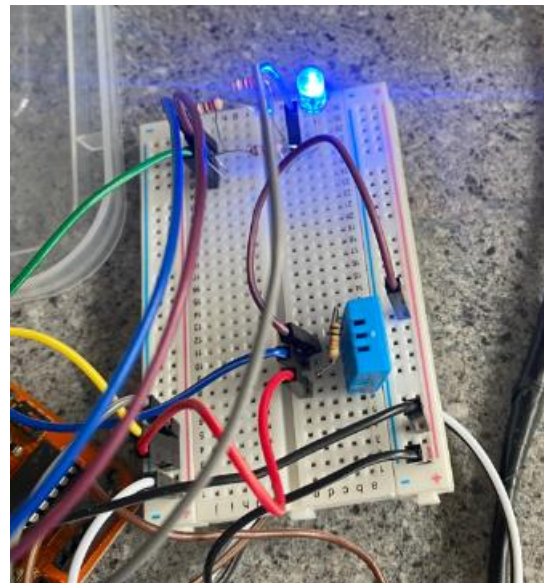


Figure 7- RGB emits blue when temperature is below 16°C.

Accessed on 05/05/23.

Test 3 was carried out to ensure when the temperature is below 16°C the RGB emits blue. Figure 7 shows that when the temperature went below 16 °C the RGB turns blue to show the user that the room is too cold and below the comfortable working conditions and the heating needs to be turned on or up. To carry out the test freeze spray was used and the temperature on the LCD shows that the test has worked.

Test 4

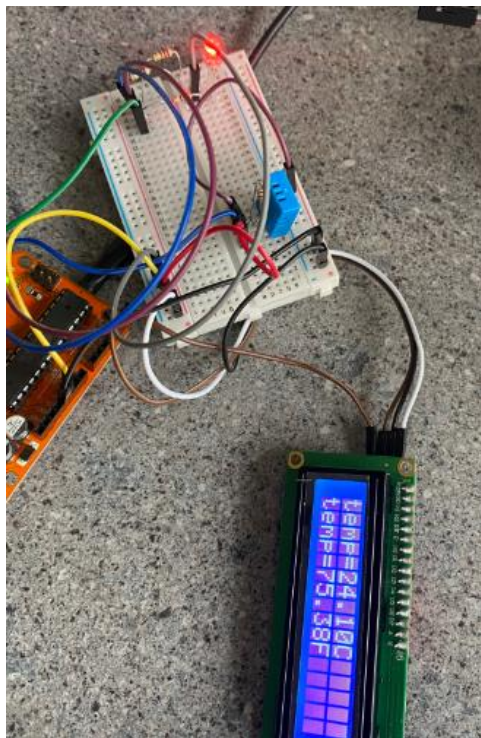
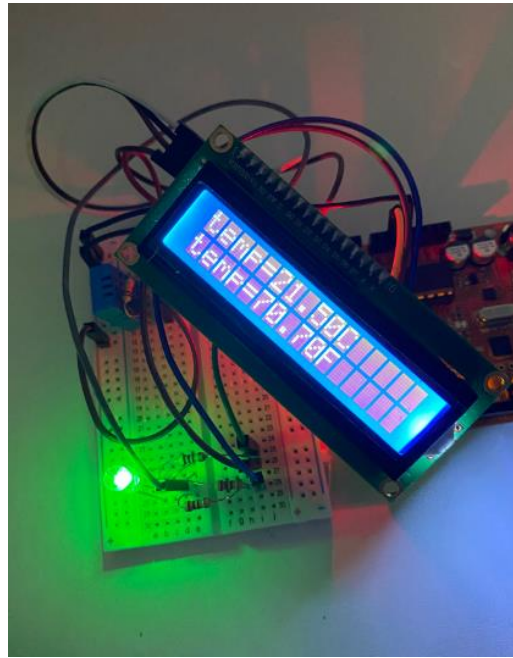


Figure 8- RGB emits red when temperature is above 24°C.

Accessed on 05/05/23.

Test 4 was carried out to ensure when the temperature is above 24°C the RGB emits Red. Figure 8 shows that when the temperature went above 24°C the RGB turns Red to show the user that the room is too hot and above the comfortable working conditions meaning the heating needs to be turned off and open windows.

Test 5



Lastly test 5 was to ensure that when the temperature was between 16-24 °C the RGB would emit Green to show the user that the room is at a comfortable working condition. Figure 9 shows that this test proved the system was working to the expected outcome.

*Figure 9- RGB emits green when the temperature is between 16-24 °C.
Accessed on 05/05/2023.*

Task 5- Discussion, Evaluation and conclusions

The office environment monitors produced works well to the required project. The program runs smoothly and works to the flow diagram produced at the start. The monitor allows the user to know the environment and when its not at a comfortable condition.

Although the monitor system works well there is room for improvement.

Firstly, if people in the office are concentrating on work, they may not notice the RGB changing colour when the room condition changes. This could be improved by also adding a buzzer to buzz for 5 seconds when the environment changes. This would improve the monitor as it would grab the workers attention if they were within the room. Lastly the Monitor works currently on a plug-in port by plug or computer. This limits the location of where it can be placed and the monitor from being turned off.

This could be improved by changing it to a battery supply.

The C programming language is used for embedded systems mainly due to its simplicity and is also a highly portable language. The programs coded in it are far faster and more efficient when compared to other programming languages. This is because of the usefulness of there not being many keywords or symbols being involved. This allows users to get started with C programming easy as you can pick it up quickly with examples and tutorials online. A great power of C programming is the presence of many libraries. These are “built-in functions which consist of system-generated functions and user-defined functions” (Vatsal, 2022). The function can be made to the user’s requirement as used in the office environment monitor above in the code. The program also has the power of producing machine codes very fast and being portable allowing users to use different platforms. The code is made simple and easy to learn because it’s a procedure-oriented language. Lastly the C programming language is useful for easy debugging as it lets you stop the process immediately and shows you the problematic statement which is causing the issue.

Office Environment Monitor

To conclude, overall, the Office Environment Monitor produced was a success. This is believed due to the monitor in use allowing the user to know the temperature and acknowledge when it's not within comfortable environment. This was done by using the DHT11 to input the room temperature which then outputs to the LCD and RGB. This then shows the user the exact room temperature and when the room is within the comfortable environment or not by using different colours for whether it's too warm, cold, or comfortable. The comfortable environment temperature was decided upon research online using multiple sources to meet the requirements. This monitor allows the user to know the exact temperature to guide them on changing the heating temperature. Overall, the office environment monitor meets the requirement as it allows the user to monitor the office and know when action needs to be taken and how.

References

ARDUINO, 2023. *What is Arduino?*. [Online]

Available at: <https://docs.arduino.cc/learn/starting-guide/whats-arduino>

[Accessed 4 May 2023].

Dfrobot, 2023. *Digital-output relative humidity & temperature*. [Online]

Available at: <https://image.dfrobot.com/image/data/KIT0003/DHT11%20datasheet.pdf>

[Accessed 4 May 2023].

GOV.UK, 2023. *Workplace Temperatures*. [Online]

Available at: [https://www.gov.uk/workplace-](https://www.gov.uk/workplace-temperatures#:~:text=However%2C%20guidance%20suggests%20a%20minimum,temperature%20at%20a%20comfortable%20level)

[temperatures#:~:text=However%2C%20guidance%20suggests%20a%20minimum,temperature%20at%20a%20comfortable%20level](https://www.gov.uk/workplace-temperatures#:~:text=However%2C%20guidance%20suggests%20a%20minimum,temperature%20at%20a%20comfortable%20level)

[Accessed 22 March 2023].

RS, 2023. *Full Colour RGB Lamps*. [Online]

Available at: <https://docs.rs-online.com/b59a/0900766b801fff40.pdf>

[Accessed 4 May 2023].

RS, 2023. *PC 1602-D*. [Online]

Available at: <https://docs.rs-online.com/f6a3/0900766b81385b8f.pdf>

[Accessed 4 May 2023].

Static.Rapidonline, 2023. *Kona328 Arduino*. [Online]

Available at: https://static.rapidonline.com/pdf/75-0550_v1.pdf

[Accessed 04 May 2023].

TUC, 2023. *Health and Safety Time for Change*. [Online]

Available at: <https://www.tuc.org.uk/sites/default/files/Temperature.pdf>

[Accessed 22 March 2023].

Vatsal, S., 2022. *Advantages And Disadvantages of C Programming Language*. [Online]

Available at: <https://unstop.com/blog/advantages-and-disadvantages-of-c-programming-language>

[Accessed 05 May 2023].

Bibliography

Richard, B., 2014. *Arduino Programming*. s.l.:Pearson Education.

Sommerville, I., 2016. *Software Engineering*. 10th ed. s.l.:Pearson Education.

Appendix



Kona328 Arduino UNO Compatible Development Board

Order code: **75-0550**

Overview

The Kona328 is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Kona328 differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. Revision 2 of the Kona328 board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Power

The Kona328 can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

VIN The input voltage to the Kona328 board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.



5V The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.

3V3 A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

GND Ground pins.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Kona328 can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX) Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

External Interrupts: 2 and 3 These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11 Provide 8-bit PWM output with the analogWrite() function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK) These pins support SPI communication using the SPI library.

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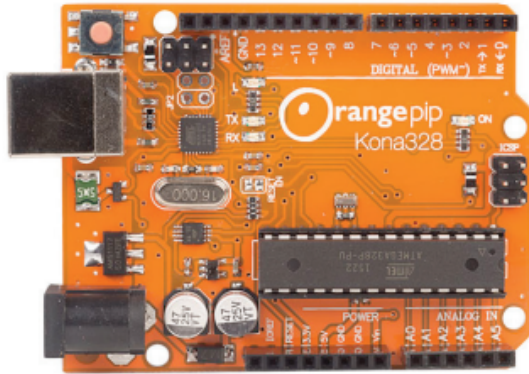
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Figure 10-Orange Pip Kona328 datasheet Page 1-3 (Static.Rapidonline, 2023)



Kona328 Arduino UNO Compatible Development Board

Order code: **75-0550**



LED: 13 There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Kona328 has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and the `analogReference()` function. Additionally, some pins have specialized functionality:

TWI: A4 (SDA) and A5 (SCL) Support TWI communication using the `Wire` library. There are a couple of other pins on the board:

AREF Reference voltage for the analog inputs. Used with `analogReference()`.

Reset Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Orange Pi pins and ATmega328 ports?

Communication

The Kona328 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A `SoftwareSerial` library allows for serial communication on any of the Kona328's digital pins.

The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a `Wire` library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the `SPI` library. Programming

The Kona328 can be programmed with the Arduino software. Select "Arduino Uno" from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Kona328 comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega8U2 firmware source code is available. The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Kona328 is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Kona328 is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Kona328. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

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Figure 11 Orange Pi Kona328 datasheet Page 2-3 (Static.Rapidonline, 2023)



Kona328 Arduino UNO Compatible Development Board

Order code: **75-0550**

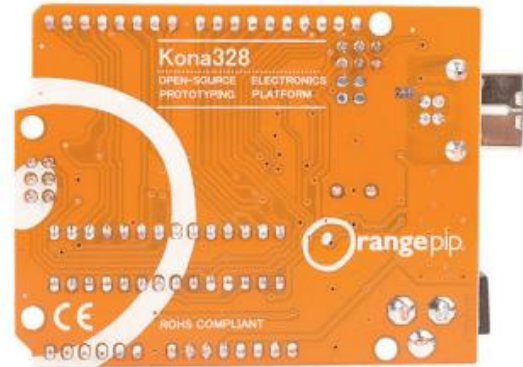
The Kona328 contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line.

USB Overcurrent Protection

The Kona328 has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Kona328 PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.



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Figure 12-Orange Pip Kona328 datasheet Page 3-3 (Static.Rapidonline, 2023)

LF5WAEMBGMBBC HIGH EFFICIENCY RED / BLUE / GREEN

LF5WAEMBGMBW HIGH EFFICIENCY RED / BLUE / GREEN

Features

- TWO BLUE, ONE GREEN AND ONE RED CHIPS IN ONE PACKAGE.
- CAN PRODUCE ANY COLOR IN VISIBLE SPECTRUM, INCLUDING WHITE LIGHT.
- WIDE VIEWING ANGLE FOR DIFFUSED LENS AND HIGH INTENSITY FOR WATER CLEAR LENS.

Description

The High Efficiency Red source color devices are made with Gallium Arsenide Phosphide on Gallium Phosphide Orange Light Emitting Diode.

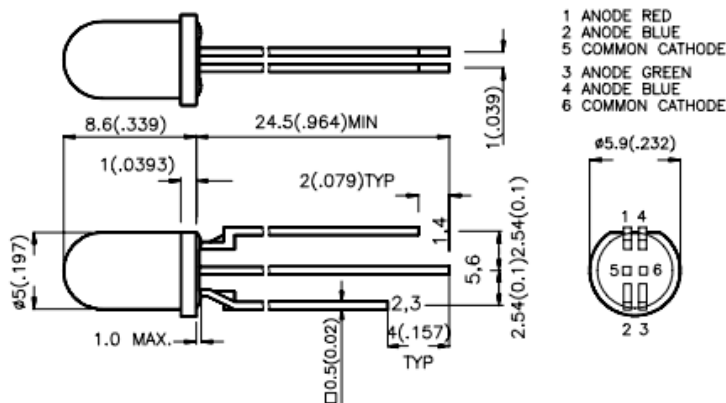
The Blue source color devices are made with GaN on SiC Light Emitting Diode.

Static electricity and surge damage the LEDs. It is recommended to use a wrist band or anti-electrostatic glove when handling the LEDs.

All devices, equipment and machinery must be electrically grounded.

The Green source color devices are made with Gallium Phosphide Green Light Emitting Diode.

Package Dimensions



Notes:

1. All dimensions are in millimeters (inches).
2. Tolerance is $\pm 0.25(0.01")$ unless otherwise noted.
3. Lead spacing is measured where the lead emerge package.
4. Specifications are subject to change without notice.

SPEC NO: KDA0198

REV NO: V.1

DATE: OCT/04/2001

PAGE: 1 OF 4

APPROVED: J.LU

CHECKED:

DRAWN: J.X.FU

Figure 13- RGB LED Datasheet page 1 of 4 (RS, 2023)

Selection Guide

Part No.	Dice	Lens Type	Iv (mcd) @ 20 mA		Viewing Angle
			Min.	Typ.	2 θ 1/2
LF5WAEMBGMBBC	HIGH EFFICIENCY RED (GaAsP/GaP)	WATER CLEAR	20	50	30°
	BLUE(GaN)		20	40	
	GREEN (GaP)		12	30	
	BLUE(GaN)		20	40	
LF5WAEMBGMBW	HIGH EFFICIENCY RED (GaAsP/GaP)	WHITE DIFFUSED	12	30	60°
	BLUE(GaN)		12	20	
	GREEN (GaP)		12	25	
	BLUE(GaN)		12	20	

Note:

1. θ 1/2 is the angle from optical centerline where the luminous intensity is 1/2 the optical centerline value.

Electrical / Optical Characteristics at T_A=25°C

Symbol	Parameter	Device	Typ.	Max.	Units	Test Conditions
λ_{peak}	Peak Wavelength	High Efficiency Red Green Blue	627 565 430		nm	IF=20mA
λ_D	Wavelength At Peak	High Efficiency Red Green Blue	625 568 455		nm	IF=20mA
$\Delta\lambda_{1/2}$	Spectral Line Halfwidth	High Efficiency Red Green Blue	45 30 60		nm	IF=20mA
C	Capacitance	High Efficiency Red Green Blue	15 15 65		pF	V _F =0V;f=1MHz
V _F	Forward Voltage	High Efficiency Red Green Blue	2.0 2.2 4.0	2.5 2.5 4.5	V	IF=20mA
I _R	Reverse Current	All	10		uA	VR = 5V

Absolute Maximum Ratings at T_A=25°C

Parameter	High Efficiency Red	Green	Blue	Units
Power dissipation	105	105	105	mW
DC Forward Current	30	25	30	mA
Peak Forward Current [1]	160	140	150	mA
Reverse Voltage	5	5	5	V
Operating/Storage Temperature	-40°C To +85°C			
Lead Soldering Temperature [2]	260°C For 5 Seconds			

Notes:

- 1/10 Duty Cycle, 0.1ms Pulse Width.
- 4mm below package base.

SPEC NO: KDA0198

REV NO: V.1

DATE: OCT/04/2001

PAGE: 2 OF 4

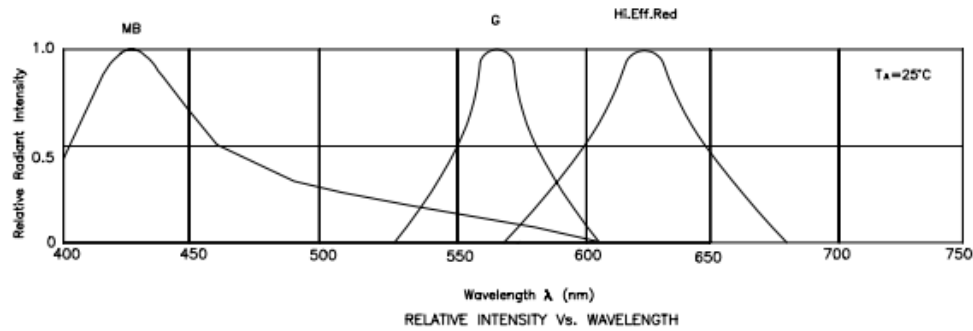
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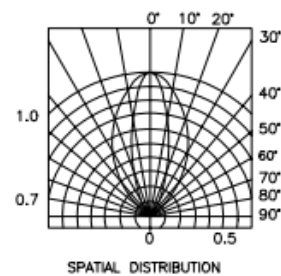
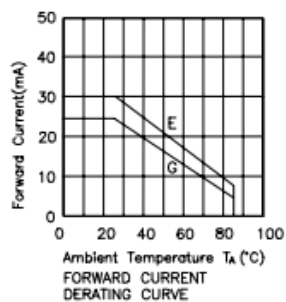
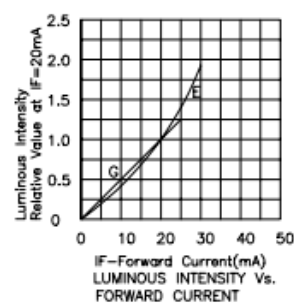
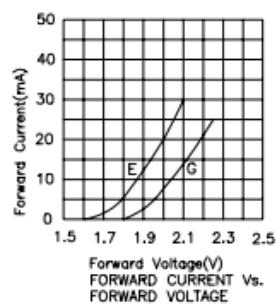
DRAWN: J.X.FU

Figure 14- RGB LED Datasheet page 2 of 4 (RS, 2023)

Kingbright



LF5WAEMBGMB, LF5WAEMBGMBW High Efficiency Red / Green



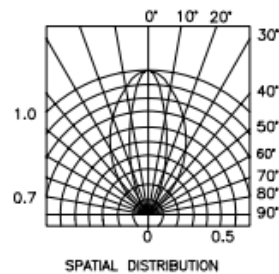
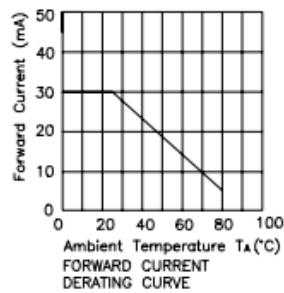
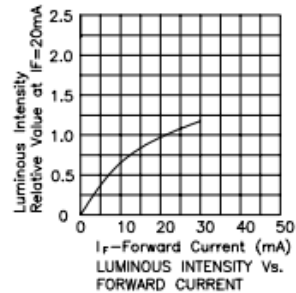
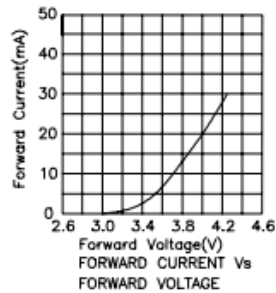
SPEC NO: KDA0198
APPROVED: J.LU

REV NO: V.1
CHECKED:

DATE: OCT/04/2001
DRAWN: J.X.FU

PAGE: 3 OF 4

Figure 15- RGB LED Datasheet page 3 of 4 (RS, 2023)

Kingbright**LF5WAEMBGMB, LF5WAEMBGMB
BLUE**

SPEC NO: KDA0198

REV NO: V.1

DATE: OCT/04/2001

PAGE: 4 OF 4

APPROVED: J.LU

CHECKED:

DRAWN: J.X.FU

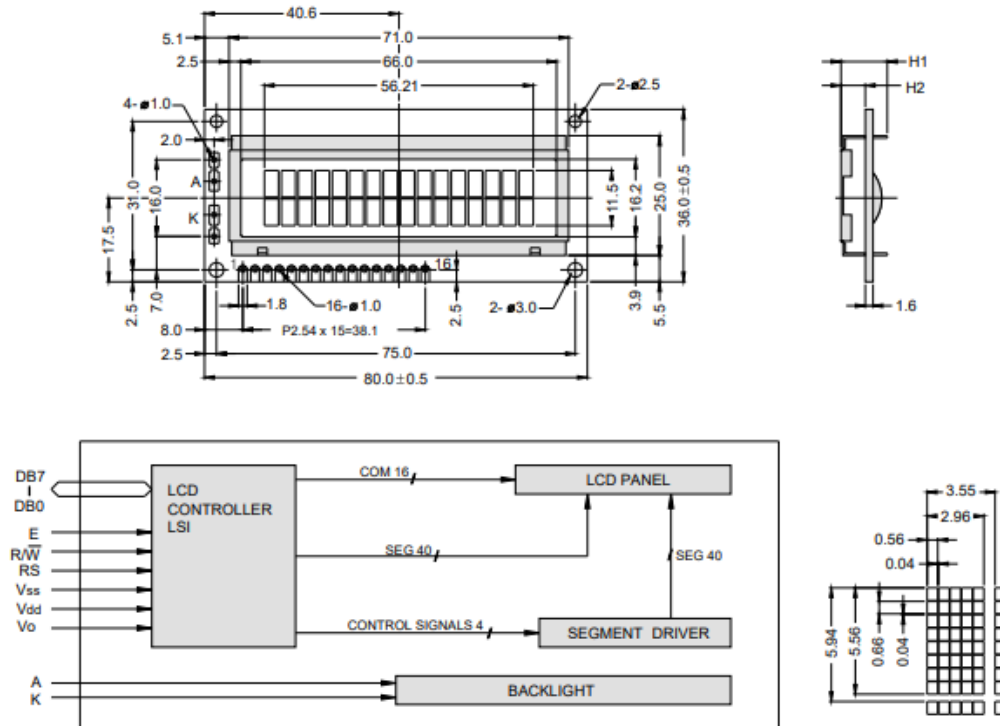
Figure 16- RGB LED Datasheet page 4 of 4 (RS, 2023)



PC 1602-D



OUTLINE DIMENSION & BLOCK DIAGRAM



The tolerance unless classified $\pm 0.3\text{mm}$

MECHANICAL SPECIFICATION			
Overall Size	80.0 x 36.0	Module	H2 / H1
View Area	66.0 x 16.2	W / O B/L	5.1 / 9.7
Dot Size	0.56 x 0.66	EL B/L	5.1 / 9.7
Dot Pitch	0.60 x 0.70	LED B/L	9.4 / 14.0

PIN ASSIGNMENT		
Pin no.	Symbol	Function
1	Vss	Power supply(GND)
2	Vdd	Power supply(+)
3	Vo	Contrast Adjust
4	RS	Register select signal
5	R/W	Data read / write
6	E	Enable signal
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
15	A	Power supply for LED B/L (+)
16	K	Power supply for LED B/L (-)

ABSOLUTE MAXIMUM RATING					
Item	Symbol	Condition	Min.	Max.	Units
Supply for logic voltage	Vdd-Vss	25°C	-0.3	7	V
LCD driving supply voltage	Vdd-Vee	25°C	-0.3	13	V
Input voltage	Vin	25°C	-0.3	Vdd+0.3	V
ELECTRICAL CHARACTERISTICS					
Item	Symbol	Condition	Min.	Typical	Max. Units
Power supply voltage	Vdd-Vss	25°C	2.7	—	5.5 V
LCD operation voltage	Vop	Top	N	W	N W V
		-20°C	—	7.1	— 7.5 V
		0°C	4.5	—	4.8 — 5.1 V
		25°C	4.1	6.1	4.1 6.4 4.7 6.7 V
		50°C	3.8	—	3.8 — 4.4 V
LCM current consumption (No B/L)	Idd	Vdd=5V	—	2	3 mA
		LED/edge VB/L=4.2V	—	—	— mA
Backlight current consumption	LED/array	VB/L=4.2V	—	120	— mA

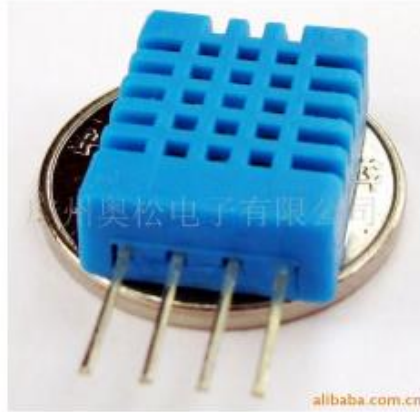
REMARK

LCD option: STN, TN, FSTN

Backlight Option: LED, EL Backlight feature, other Specs not available on catalog is under request.

Figure 17- LCD Datasheet (RS, 2023)

Digital-output relative humidity & temperature sensor/module – DHT11



Resistive-type humidity and temperature module/sensor

1. Feature & Application:

- * Full range temperature compensated
- * Relative humidity and temperature measurement
- * Calibrated digital signal
- * Outstanding long-term stability
- * Extra components not needed
- * Long transmission distance
- * Low power consumption
- * 4 pins packaged and fully interchangeable

2. Description:

DHT11 output calibrated digital signal. It utilizes exclusive digital-signal-collecting-technique and humidity sensing technology, assuring its reliability and stability. Its sensing elements is connected with 8-bit single-chip computer.

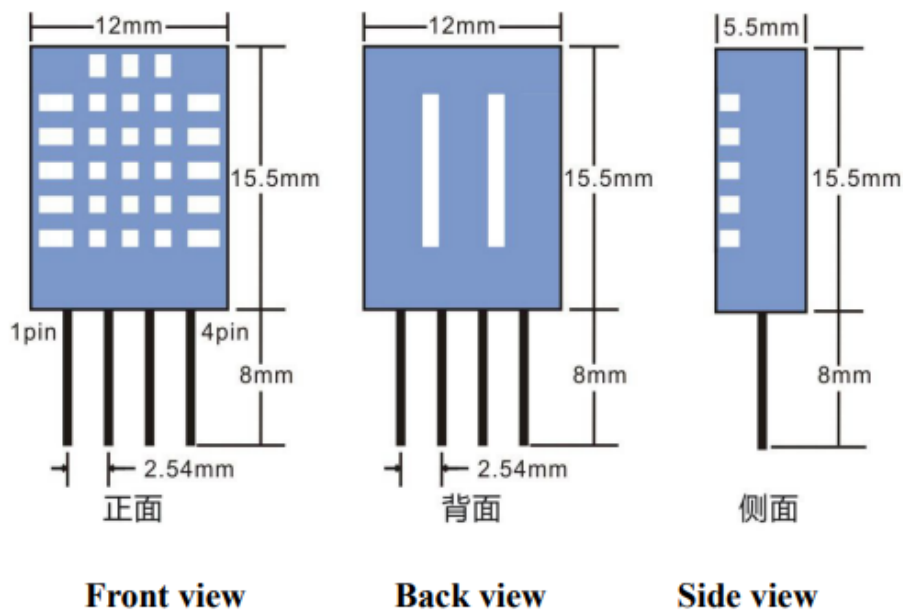
Every sensor of this model is temperature compensated and calibrated in accurate calibration chamber and the calibration-coefficient is saved in OTP memory.

Small size & low consumption & long transmission distance(20m) enable DHT11 to be suited in all kinds of harsh application occasions. Single-row packaged with four pins, making the connection very convenient.

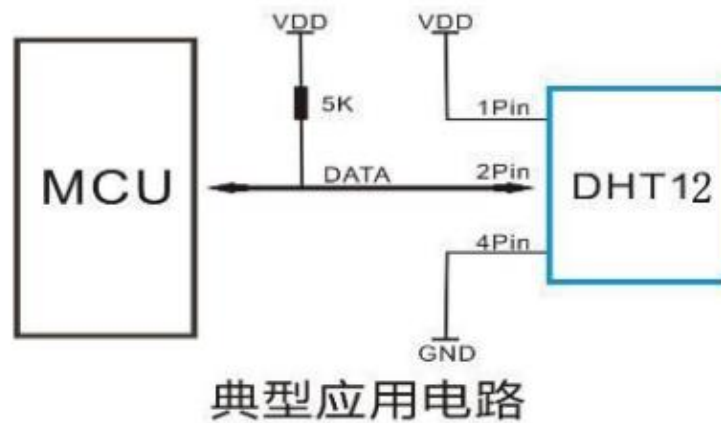
3. Technical Specification:

Model	DHT11		
Power supply	3-5.5V DC		
Output signal	digital signal via single-bus		
Sensing element	Polymer resistor		
Measuring range	humidity 20-90%RH; temperature 0-50 Celsius		
Accuracy	humidity $\pm 4\%$ RH (Max $\pm 5\%$ RH); temperature ± 2.0 Celsius		
Resolution or sensitivity	humidity 1%RH;	temperature 0.1 Celsius	
Repeatability	humidity $\pm 1\%$ RH;	temperature ± 1 Celsius	
Humidity hysteresis	$\pm 1\%$ RH		
Long-term Stability	$\pm 0.5\%$ RH/year		
Sensing period	Average: 2s		
Interchangeability	fully interchangeable		
Dimensions	size 12*15.5*5.5mm		

4. Dimensions: (unit----mm)



5. Typical application



3Pin-NULL, MCU=Microcomputer or single-chip computer

6. Operating specifications:

(1) Power and Pins

Power's voltage should be 3-5.5V DC. When power is supplied to sensor, don't send any instruction to the sensor within one second to pass unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.

(2) Communication and signal

Single-bus data is used for communication between MCU and DHT11.

7. Electrical Characteristics:

Item	Condition	Min	Typical	Max	Unit
Power supply	DC	3	5	5.5	V
Current supply	Measuring	0.5		2.5	mA
	Stand-by	100	Null	150	uA
	Average	0.2	Null	1	mA

Figure 20- DHT11 Datasheet page 3 of 3 (Dfrobot, 2023)