

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	James Hammond	Student ID number:	2015859
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.

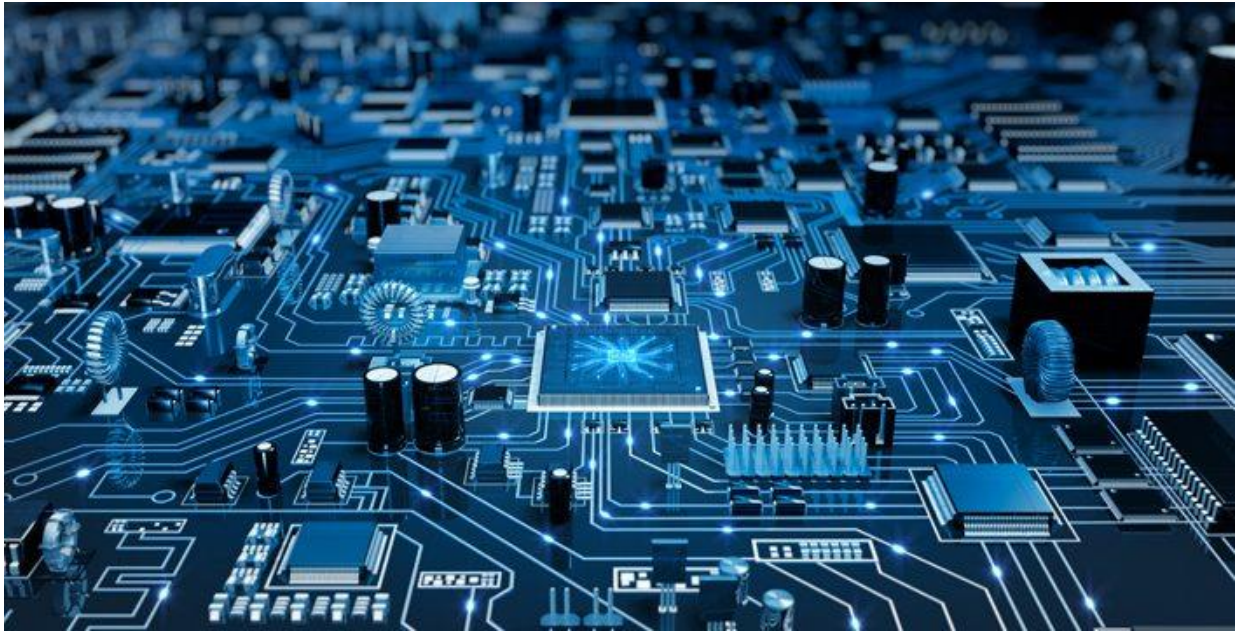
STUDENT FEEDBACK FORM

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 a limited knowledge of the basic underlying concepts and principles. Be careful not to confuse hardware with software, the Arduino Uno is the microcontroller board, whereas the Arduino IDE is the software used to develop the code to make the microcontroller function and allow the code to be uploaded onto the board. Try to avoid wires crossing the pins on the Arduino in your schematic, as it can be difficult to determine which pin the component is actually connected too, particularly with more complex circuits. Very limited discussion with regards to considering other components, more marks would have been gained here had you discussed some alternatives you considered and why you ultimately decided they were not used. 6/15 Software Limited knowledge of the basic underlying concepts and principles. Flowchart provided conforms to standards and is largely correct. However, you are missing a path, and also your decision boxes should have T/F or Y/N on the paths exiting them to indicate the flow of the program. There seems to be no reference to switching OFF the LEDs if the temperature changes from one state to another one. Further marks here would have been gained by including pseudocode. 7/15	30	13
3. Cognitive and Intellectual Skills		
Discussion, Evaluation and Conclusion Limited attempt at evaluation of the underlying concepts and principles, tending towards description. You have not considered the usefulness of the C language which when working with microcontrollers, very good when working with hardware and considerably lighter than other languages. You have given some considerations of the improvements that can be made to the system, as well as how you could have improved your testing. 7/15	15	7
4. Practical Application Skills		
Implementation An adequate awareness and mostly appropriate application of basic methods Program is functional and meets the requirements of the assignment. Code is not annotated, you have explained what each line does, but annotation is "commenting" code, which is not the same. Comments in C use // or /* */ and are an important part	50	24.5

of developing software to aid understanding and development as well as future maintenance of a program. You have declared constants for your pins, which is good practice, but then not used them in the program. You also have a variable called length that you do not use. I understand you would use Serial.print for testing, however the reality is that this device will not be run from a PC, so for the actual use of this device, you should comment this code out. Further marks could have been achieved if you had used functions. 19.5/40 Testing A good and appropriate application of basic testing techniques has been used. Testing covers all possible states of the system, your testing table suggests you are considering the boundaries of your state changes, which is good practice, however the DHT11 is returning values to 1 decimal place so an appropriate boundary test would be 16.0 and 16.1 in the table as well as 24 and 24.1 5/10		
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, including contents page, referenced statements where required and clearly 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)		48.5%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		



Office Environment Monitor

Module: Embedded Systems

Lecturer: Sarah Williams

Author: James Hammond

Contents

Introduction.	2
Working conditions.	2
Hardware Design.....	2
Orangepip Kona328.	2
Digital relative humidity and temperature sensor (DHT11).	2
Piezo buzzer.	3
Red, Green and Yellow LEDs.	3
Software Design.	4
System Explanation.....	6
Testing.....	8
Discussion, Evaluation & Conclusion.	13
Bibliography and References.	14
Appendix	15
Appendix 1	15
Appendix 2	21
Appendix 3.	25
Appendix 4.	26
Appendix 5.	27
Appendix 6.	28

Introduction.

Since there are concerns raised over the effectiveness of the heating and air conditioning in the place of work, I have been tasked to design a microcontroller-based system which will indicate when the working conditions become out of “normal” working conditions. This report will look at the research required, the design of the product, the implementation and testing of the system and the documentation for components used. The place of work will be Pembrokeshire College.

Working conditions.

Although there is no legal maximum or minimum working conditions within schools and colleges, it is generally accepted that the optimum working temperature is between 16°C and 24°C. Since there are no legal limits, the legality of working conditions will fall under the Health and Safety at Work act 1974, which requires employers to ensure the health, safety and wellbeing of their staff and others present in the workplace, this includes students. It also states that “The minimum temperature in an indoor workplace should normally be at least:

- 16°C or
- 13°C if much of the work involves rigorous physical effort.”¹

Regarding hot temperatures, the Health and Safety Executive (HSE) states “all workers are entitled to an environment where risks to their health and safety are properly controlled. Heat is classed as a hazard and comes with legal obligations like any other hazard.”²

The National Education Unions policy states “that 26°C should be the absolute maximum temperature in which staff should be expected to work”.³

I will set the parameters of the Temperature monitor to the lower limit of 16°C and the upper limit to 24°C to coincide with the optimum working temperatures.

Hardware Design.

The components I decided to use for this sensor were:

OrangePi Kona328.

OrangePi Kona328 is a development board, which features 14 digital I/O pins, and 6 analog inputs. It is easy to use and requires connection to the computer via USB. It is compatible with Arduino UNO which will be the programme of choice. The data sheet for this component can be found in [Appendix 6](#)

Digital relative humidity and temperature sensor (DHT11).

The DHT11 is a low-cost temperature and humidity sensor, easily interfaced with the microcontroller. It uses capacitive humidity sensor and a thermistor to measure the

¹ [Is it too cold or hot to work? \(hse.gov.uk\)](https://www.hse.gov.uk/temperature/)

² [Temperature: What the law says \(hse.gov.uk\)](https://www.hse.gov.uk/temperature/)

³ [Hot weather and classroom temperature | NEU](#)

environment and gives a digital signal to the data pin. The sensor is capable of measuring from 0-50°C, with a 2% accuracy. This is more than adequate for what is required from the office environment sensor. It consists of a VCC pin which is the control voltage, a GND pin which is the ground, and a DATA pin for communication. The data sheet for this component can be seen in [Appendix 1](#).

Piezo buzzer.

The piezo buzzer was chosen for its compatibility, size and effectiveness in attracting the attention when the temperature is out of the desired tolerance. It has a large voltage range and offers good frequency response. An alternative to the Piezo buzzer was a magnet buzzer, as I didn't require a lower range of frequencies or a lower pitched sound I decided this was not an option. The piezo buzzers compact design and high pitched output make this a good choice for the office environment sensor. The datasheet for this buzzer can be found in [Appendix 2](#).

Red, Green and Yellow LEDs.

This is a quick visual representation of the temperature. The light emitting diode (LED) has two metal legs the longer being the Anode or positive and the shorter the cathode or negative. If the temperature is within normal limits, then the green LED ([Appendix 4](#)) will illuminate, if the temperature should fall below the desired limit then the yellow LED ([Appendix 5](#)) will illuminate, and then should the temperature increase to above the normal limit then the red LED will illuminate. I did consider using a RGB LED ([Appendix 3](#)), but I thought it would have more of an eye-catching effect and be more aesthetically pleasing using three separate LEDs. The datasheets can be found in the attached Appendix' 3, 4 and 5.

Resistors are added to the circuit to protect the LEDs from excessive current which can damage the LEDs. Resistors limit the current to within a range that is acceptable for the LEDs to operate.

Once all the components are sourced the circuit will then be assembled, below in figure 1, is the schematic view of the configuration.

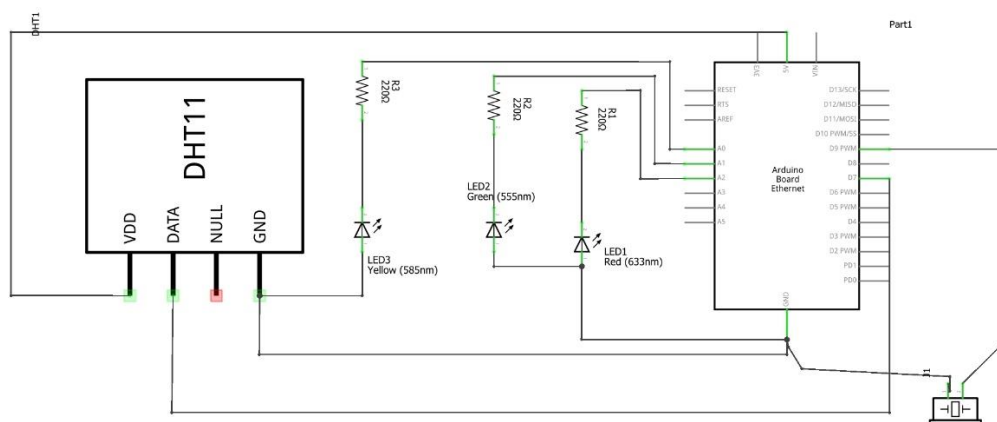


Figure 1

Software Design.

Using a flow diagram to assist in designing a programme to test the environment in a room, I would alert the user if the temperature were outside the “comfortable working conditions”.

The comfortable working conditions are between 16°C and 24°C.

4 James Hammond

Once the DHT has read and displayed the reading, if the temperature is $<16^{\circ}\text{C}$ then it will establish that the temperature is “Too Cold” and illuminate the yellow LED. After a short delay, it will then sound the buzzer.

If the temperature is between $16\text{--}24^{\circ}\text{C}$, then it will indicate the “perfect temperature” then the green LED will illuminate.

If the temperature is $>24^{\circ}\text{C}$ then the system will indicate the temperature is “Too Hot” by illuminating the red LED, then after a short pause the buzzer will sound.

After all these possibilities there will be a small delay before the sensor continues reading the environment and repeats the process. The sensor will run continuously while there is power it or until it is given the command to stop.

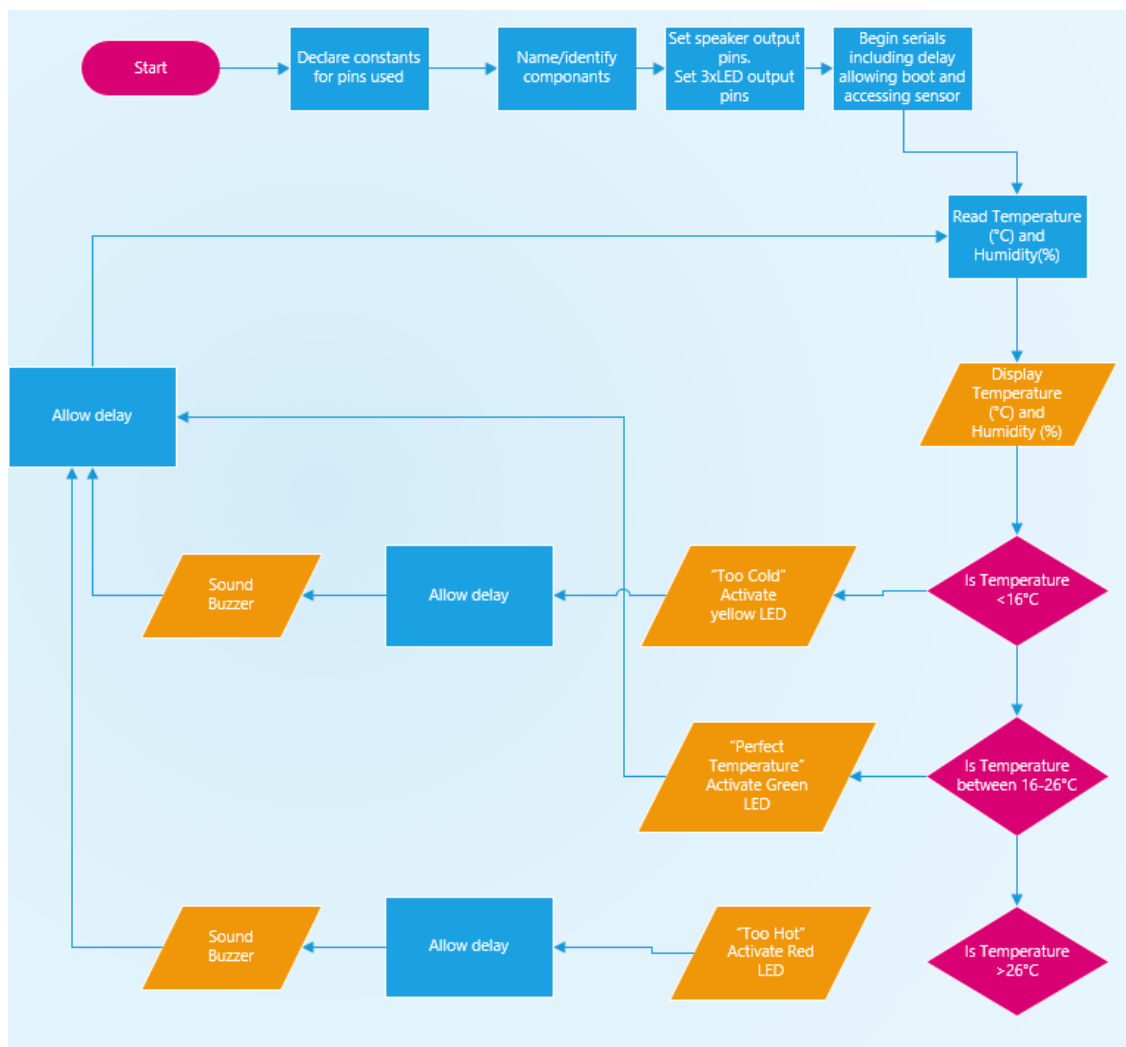


Figure 3

System Explanation.

Following the software design, the code is written below, and the explanation is given in red.

```
#include "DHT.h"           Importing the library.

int speakerPin = 9;        Naming and identifying speaker/buzzer pin.

int length = 1;

#define DHT11_PIN 7        Identifying the DHT sensor and the associated pin 7.
#define LED_COLD A0        Identifying the Yellow LED with the associated pin A0.
#define LED_GOOD A1        Identifying the Green LED with the associated pin A1.
#define LED_HOT A2;        Identifying the Red LED with the associated pin A2.

DHT tempSensor (DHT11_PIN,DHT11);

void setup() {              Setup of code here, only needs to run on startup.
    // put your setup code here, to run once:

    Serial.begin(9600); //   Upon start-up this will start the serial monitor.
    delay(500); //           Delay for 0.5 seconds allowing system to boot up.
    delay(1000); //          Delay before accessing the sensor.
    tempSensor.begin();      Start-up of sensor.
}

void loop() {               Main code in this section to run, and keep repeating. {signals
                             the start of this section.

    pinMode (speakerPin,OUTPUT); Initialise speaker/buzzer pin.
    pinMode (A0 , OUTPUT);      Initialise the digital pins as outputs.
    pinMode(A1 , OUTPUT);       For all the LEDs. pinMode tells A0, A1, A2 to output
    pinMode (A2 , OUTPUT);      data.
    delay(2000);                Allow a 2 second delay.

    float humidity=tempSensor.readHumidity(); Float allowing to store precision values
    float temp= tempSensor.readTemperature(); for both humidity and temperature.
```

Serial.print("Current humidity = ");	<i>This will indicate humidity on the serial print screen.</i>
Serial.print(humidity);	
Serial.print("% ");	<i>Give the humidity as a percentage.</i>
Serial.print("temperature = ");	<i>Indicate temperature in the serial print screen.</i>
Serial.print(temp);	
Serial.println("C ");	<i>Give the temperature in °C.</i>
if (temp <=16) {	<i>When reading the conditions if the temp is</i>
Serial.println("Too cold!");	<i>16 degrees or under it will display "too cold".</i>
digitalWrite(A0, HIGH);	<i>Initiate the yellow LED.</i>
digitalWrite(speakerPin, HIGH);	<i>Initiate the buzzer.</i>
delay (2000);	<i>Allow for a 2 second delay leaving LED on.</i>
digitalWrite(speakerPin, LOW);	<i>Turn buzzer off.</i>
digitalWrite(A0, LOW);	<i>Turn LED off, simulating flashing.</i>
}	
if (temp >16&&temp<24) {	<i>If the temperature is between 16 and 24 degrees the following happens.</i>
Serial.println("Perfect temperature!");	<i>Display in serial print "perfect temperature"</i>
digitalWrite(A1, HIGH);	<i>Initiate green LED.</i>
delay (2000);	<i>Delay for 2 seconds keeping LED illuminated.</i>
digitalWrite(A1, LOW);	<i>Turn off LED.</i>
}	
if(temp >= 24) {	<i>If the temperature is equal to or above 24°C</i>
Serial.println("Too hot!");	<i>Display the message "too hot".</i>
digitalWrite(A2, HIGH);	<i>Initiate red LED</i>
digitalWrite(speakerPin, HIGH);	<i>Initiate buzzer.</i>
delay (2000);	<i>Delay for two seconds.</i>
digitalWrite(speakerPin, LOW);	<i>Turn buzzer/speaker off.</i>

```
digitalWrite(A2, LOW);    Turn LED off.  
delay(2000);             Delay 2 seconds before accessing sensor again.  
} }
```

This then loops back to the start of loop section and runs through again continuously monitoring the environment.

Testing.

When carrying out testing of the office environment monitor, I ensured the Serial.print(temp); was opened and was displaying the reading from the DHT11 sensor. This would ensure an accurate representation of what the monitor was reading compared to the desired output of the LEDs and buzzer.

To ensure the sensor worked when “too cold” freeze spray was used. To simulate the temperature extremes a heat gun was used.

The tests carried out are shown in Table 1.

Table 1

Test no.	Testing parameters	Expected outcome.	Actual outcome.	Comments.
1	DHT 11 working on start-up.	DHT11 to read room temp. "Perfect Temperature" indicated.	DHT11 read room temperature. "Perfect temperature" reading	Proven via thermometer.
2	Middle of "perfect Temperature" limit - 20°C	Green LED will illuminate, buzzer will not sound.	Green LED illuminated; buzzer did not sound.	Serial print and thermometer confirm temperature.
3	Upper limit of "Perfect temperature" 24°C	Green LED will illuminate, buzzer will not sound.	Green LED illuminated; buzzer did not sound.	Serial print and thermometer confirm temperature.
4	Lower limit of "Perfect temperature" 16°C	Green LED will illuminate, buzzer will not sound.	Green LED illuminated; buzzer did not sound.	Serial print and thermometer confirm temperature
5	"Too Cold" limit reached - 15°C	Yellow LED will illuminate, buzzer will sound.	Yellow LED illuminated; buzzer sounded.	Fridge used to drop temperature to desired readings.
6	"Too Cold" extreme limit reached - 10°C	Yellow LED will illuminate, buzzer will sound.	Yellow LED illuminated; buzzer sounded.	Testing extremities, using fridge.
7	"Too Hot" limit reached - 25°C	Red LED will illuminate, buzzer will sound.	Red LED illuminated; buzzer sounded.	Breathing onto DHT11 to increase temperature.
8	"Too Hot" extreme limit reached - 30°C	Red LED will illuminate, buzzer will sound.	Red LED illuminated; buzzer sounded.	Breathing onto DHT11 to increase temperature.

Initial test conditions on startup – “Perfect temperature” (Figures 4, 5 and 6).

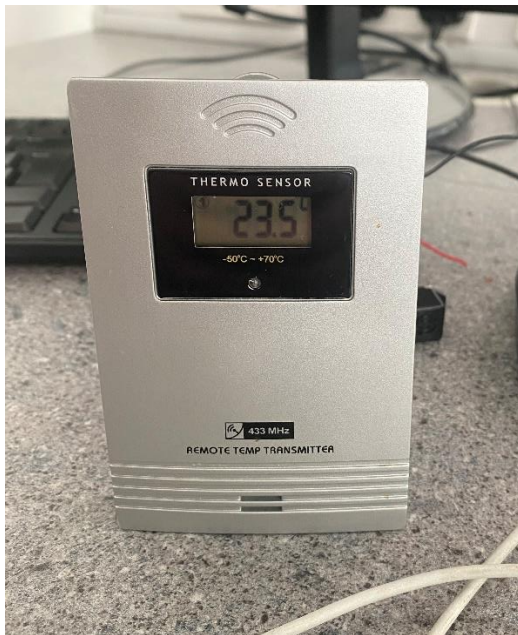


Figure 4

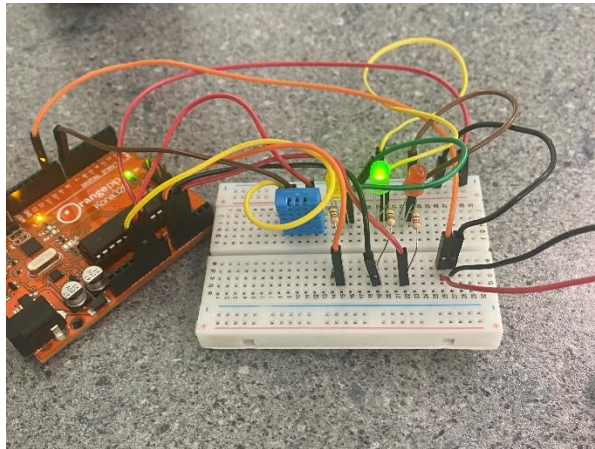


Figure 5

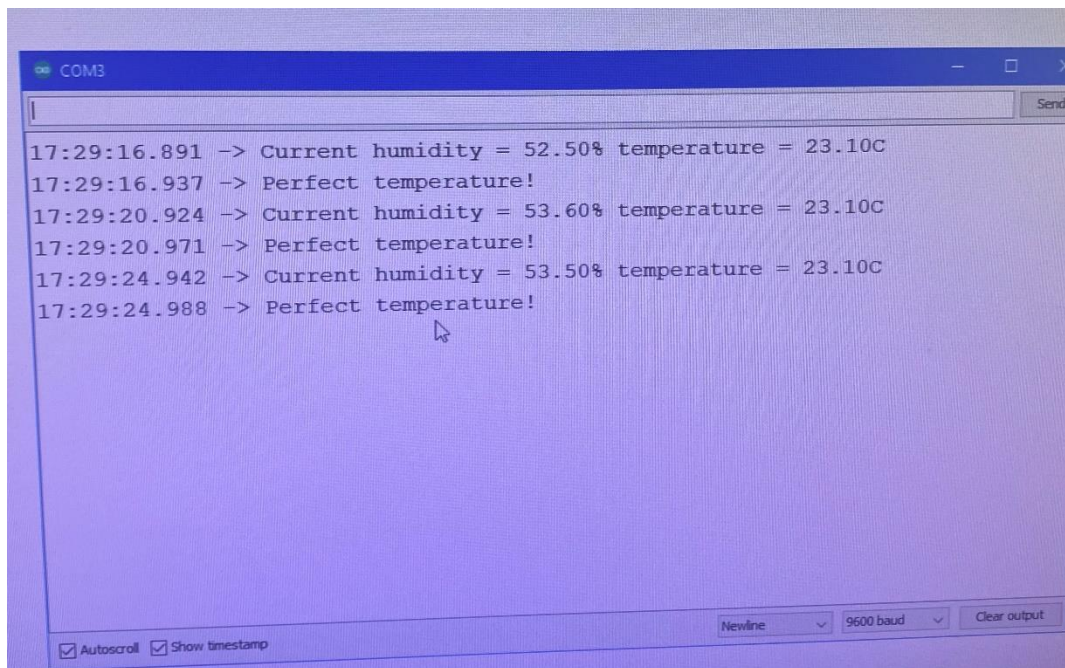


Figure 6

“Too cold” limits to extreme limits shown in figures 7 and 8.

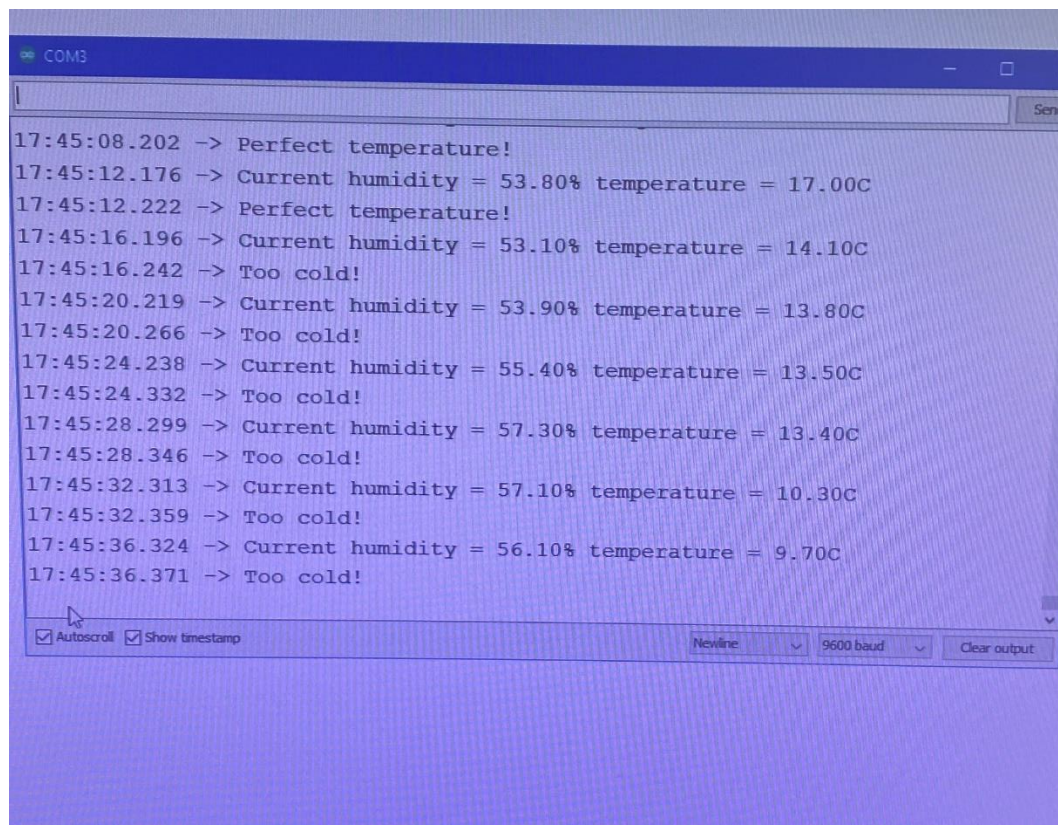


Figure 7

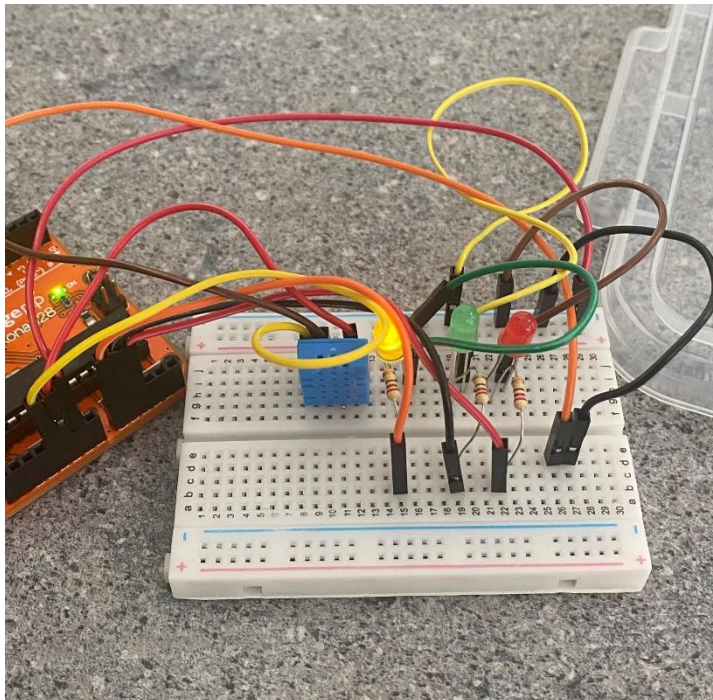


Figure 8

“Too hot” can be seen in figure 9 and 10.

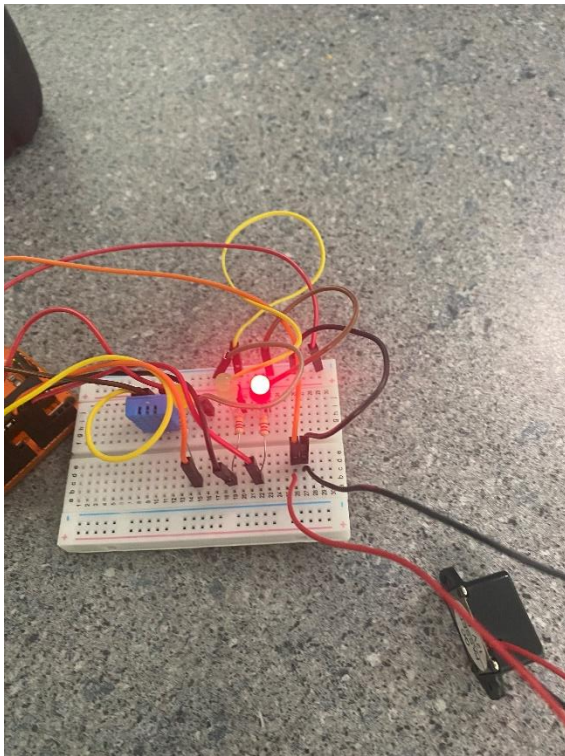


Figure 9

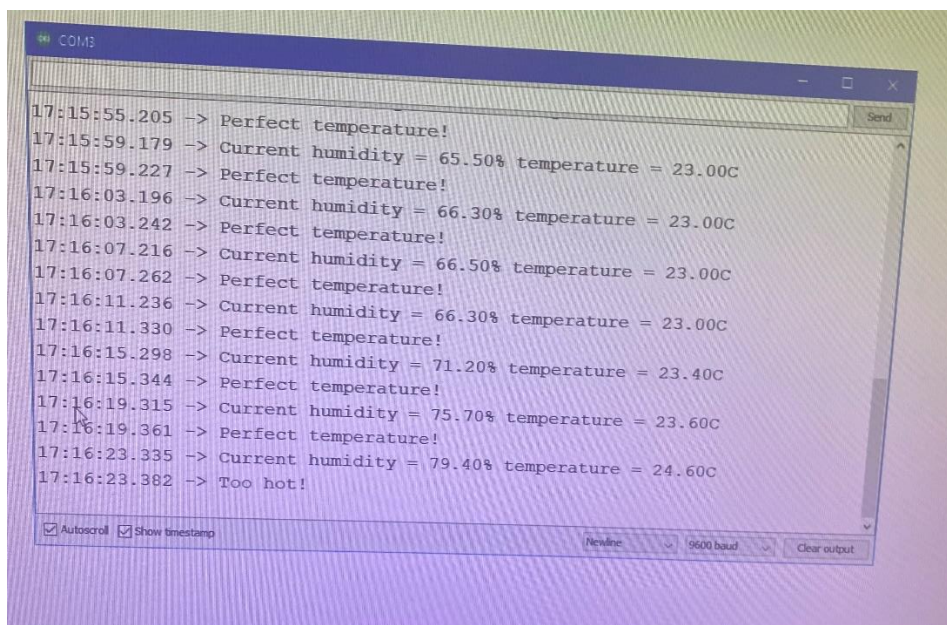


Figure 10

Discussion, Evaluation & Conclusion.

The results show that the office environment monitor works as it should in all states. I took it from extreme heat (30°C), through optimum working conditions (16-24°C), to extreme cold (10°C). The DHT11 sensor indicated the correct temperatures and the outcome of components and system reacted in the expected manner. On reflection, if I were to carry out the tests again, I would attempt to carry out a full run through of the tests uninterrupted. I would do this by using a heat gun to bring the temperature up to the upper limits and freeze spray to drop the temperature to its lower limits. I would attempt to capture this in video format to ensure accurate, uninterrupted evidence.

To make the system more user friendly, I would modify the office environment sensor by including a small LCD display which would indicate the temperature directly, rather than relying on the Serial print method of verification of exact temperature. It would also give an, and more accurate visual representation than the LEDs which only give an indication range.

Another modification that could be made to the system is a stand-alone power source, so it can be transported to other spaces and not dependant on a mains/computer power supply.

In conclusion, the requirements were met to create a simple device that will report if the temperature within a working environment goes outside the “normal” comfortable conditions which I deemed between 16°C and 24°C as guided by HSE and the National Education Union. The device indicates by buzzer and LEDs if outside these conditions and indicates if the system is inside these conditions to prove the system is working.

Bibliography and References.

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<https://neu.org.uk/advice/hot-weather-and-classroom-temperature> (Accessed: 28 April 2023).

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Dwik*, S., Amaya, M. and Somasundaram, N. (2020) 'Design and implementation of an RGB led matrix display for embedded applications', *International Journal of Innovative Technology and Exploring Engineering*, 9(3), pp. 2337–2343.
doi:10.35940/ijitee.c8855.019320.

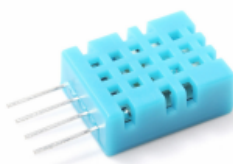
Appendix

Appendix 1

DHT11 Sensor datasheet.

AOSONG

Your specialist in innovating humidity & temperature sensors



Digital relative humidity & temperature sensor DHT11

1. Feature & Application:

- *Good precision
- *Resistive type
- *Full range temperature compensated
- *Relative humidity and temperature measurement
- *Calibrated digital signal
- *Outstanding long-term stability
- *Extra components not needed
- *Long transmission distance, up to 100 meters
- *Low power consumption
- *4 pins packaged and fully interchangeable

2. Description:

DHT11 output calibrated digital signal. It applies 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.

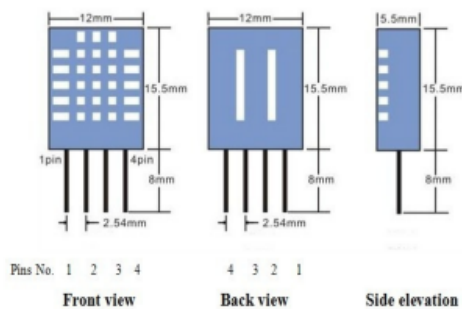
Every sensor of this model is temperature compensated and calibrated in accurate calibration chamber and the calibration-coefficient is saved in type of programme in OTP memory, when the sensor is detecting, it will cite coefficient from memory.

Small size & low consumption & long transmission distance(100m) enable DHT11 to be suited in all kinds of harsh application occasions. Single-row packaged with four pins, making the connection very convenient.

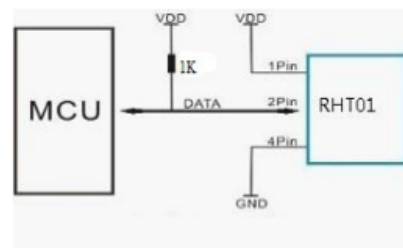
3. Technical Specification:

Model	DHT11	
Power supply	3.3-5.5V DC	
Output signal	digital signal via Aosong 1-wire bus	
Sensing element	Polymer humidity resistor	
Operating range	humidity 20-90%RH;	temperature 0~50Celsius
Accuracy	humidity +5%RH;	temperature +2Celsius
Resolution or sensitivity	humidity 1%RH;	temperature 1Celsius
Repeatability	humidity +2%RH;	temperature +1Celsius
Humidity hysteresis	+-1%RH	
Long-term Stability	+-1%RH/year	
Interchangeability	fully interchangeable	

4.Dimensions: (unit---mm)



5. Electrical connection diagram:



6. Operating specifications:

(1) Power and Pins

Power's voltage should be 3.3-5.5V 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 wave filtering.

(2) Communication and signal

Aosong 1-wire bus is used for communication between MCU and DHT11. (Aosong 1-wire bus is specially designed by Aosong Electronics Co., Ltd., it's different from Maxim/Dallas 1-wire bus, so it's incompatible with Dallas 1-wire bus.)

Illustration of Aosong 1-wire bus:

DATA=16 bits RH data+16 bits Temperature data+8 bits check-sum

Example: MCU has received 40 bits data from DHT11 as

<u>0010 0001</u>	<u>0000 0000</u>	<u>0001 1010</u>	<u>0000 0000</u>	<u>0011 1011</u>
Integral part of RH	Decimal part of RH	Integral part of T	Decimal part of T	check sum

Remarks: The decimal part of RH and T is always 0000 0000.

Here we convert integral part of RH from binary system to decimal system,

0010 0001 → 33

Binary system Decimal system, **RH=33%RH**

Here we convert integral part of T from binary system to decimal system,

0001 1010 → 26

Binary system Decimal system, **T=26 Celsius**

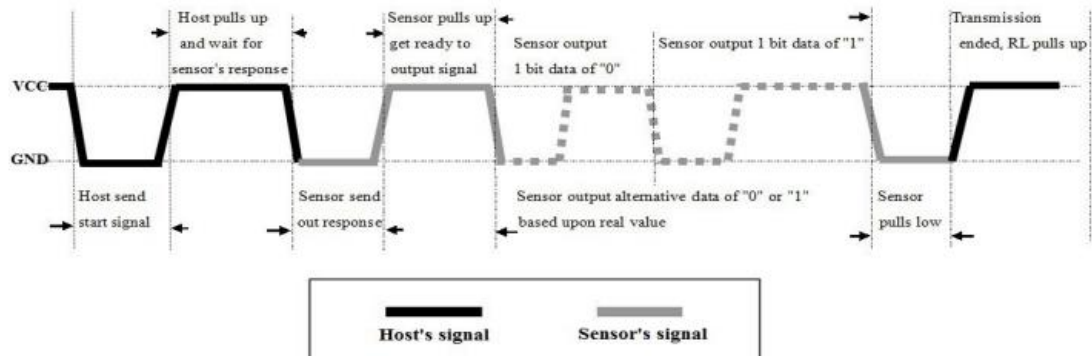
Sum=0010 0001+0000 0000+0001 1010+0000 0000=0011 1011

Check-sum=the last 8 bits of Sum=0011 1011

When MCU send start signal, DHT11 change from standby-status to running-status. When MCU finishes sending the start signal, DHT11 will send response signal of 40-bit data that reflect the relative humidity and temperature to MCU. Without start signal from MCU, DHT11 will not give response signal to MCU. One start signal for one response data from DHT11 that reflect the relative humidity and temperature. DHT11 will change to standby status

when data collecting finished if it don't receive start signal from MCU again.

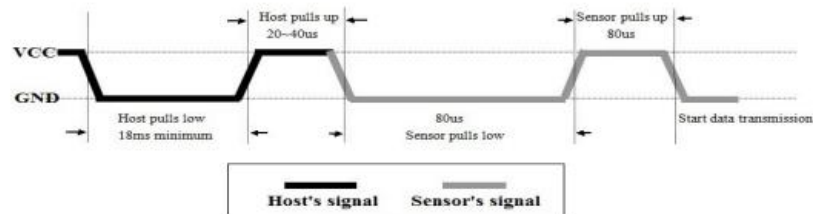
See below figure for overall communication process, the interval of whole process must beyond 2 seconds.



1) Step 1: MCU send out start signal to DHT11 and DHT11 send response signal to MCU

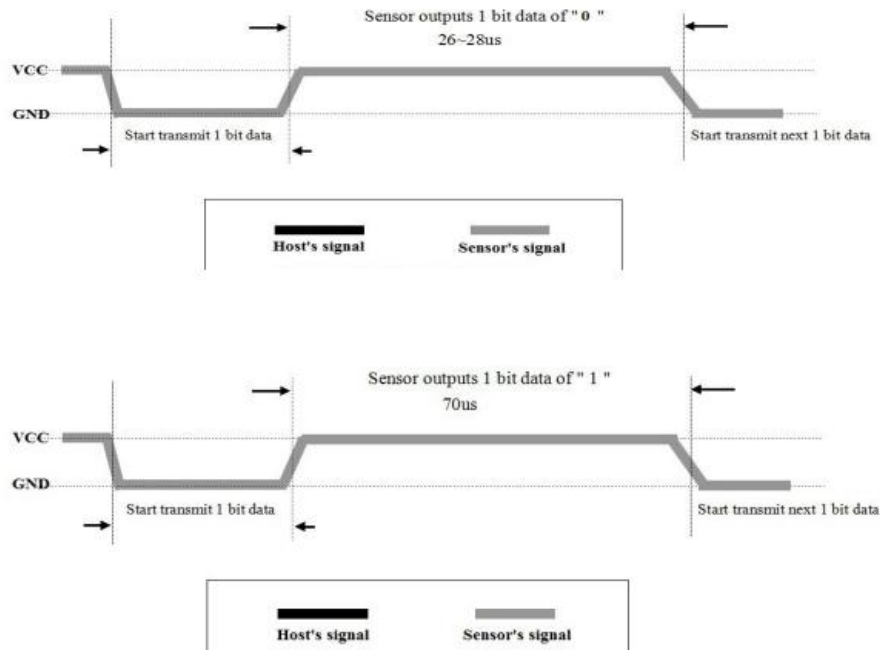
Data-bus's free status is high voltage level. When communication between MCU and DHT11 begins, MCU will pull low data-bus and this process must beyond at least 1~10ms to ensure DHT11 could detect MCU's signal, then MCU will pull up and wait 20~40us for DHT11's response.

When DHT11 detect the start signal, DHT11 will pull low the bus 80us as response signal, then DHT11 pulls up 80us for preparation to send data. See below figure:



2). Step 2: DHT11 send data to MCU

When DHT11 is sending data to MCU, every bit's transmission begin with low-voltage-level that last 50us, the following high-voltage-level signal's length decide the bit is "1" or "0". See below figures:



Attention:

If signal from DHT11 is always high-voltage-level, it means DHT11 is not working properly, please check the electrical connection status.

7. Electrical Characteristics:

Items	Condition	Min	Typical	Max	Unit
Power supply	DC	3.3	5	6	V
Current supply	Measuring	1		1.5	mA
	Stand-by	40	Null	50	uA
Collecting period	Second		2		Second

8. Error and sources of error:

Measure values maybe influenced by follow factors:

Humidity errors

Equilibration time too short, steam, water sprays, dripping water or condensation at the sensor, etc.

Temperature errors

Equilibration time too short, cold or hot outside wall, sunlights, heating elements, etc.

9. Attentions of application:

(1) Operating and storage conditions

We don't recommend the applying RH-range beyond the range stated in this specification. The DHT11 sensor can recover after working in abnormal operating condition to calibrated status, but will accelerate sensors' aging.

(2) Attentions to chemical materials

Vapor from chemical materials may interfere DHT11's sensitive-elements and debase DHT11's sensitivity.

(3) Disposal when (1) & (2) happens

Step one: Keep the DHT11 sensor at condition of Temperature 50~60Celsius, humidity <10%RH for 2 hours;

Step two: After step one, keep the DHT11 sensor at condition of Temperature 20~30Celsius, humidity >70%RH for 5 hours.

(4) Attention to temperature's affection

Relative humidity strongly depend on temperature, that is why we use temperature compensation technology to ensure accurate measurement of RH. But it's still be much better to keep the sensor at same temperature when sensing.

DHT11 should be mounted at the place as far as possible from parts that may cause change to temperature.

(5) Attentions to light

Long time exposure to strong light and ultraviolet may debase DHT11's performance.

(6) Attentions to connection wires

The connection wires' quality will effect communication's quality and distance, high quality shielding-wire is recommended.

(7) Other attentions

* Welding temperature should be bellow 260Celsius.

* Avoid using the sensor under dew condition.

* Don't use this product in safety or emergency stop devices or any other occasion that failure of DHT11 may cause personal injury.

10. Warnings:

Don't use this item on safety or emergency stop devices and any other application which may cause injury due to the failure of this item.

11. Quality Warranty:

Aosong warrants that this product will be free from defects in materials and workmanship for a period of 365 days from the date of shipment. If any such product proves defective during this warranty period, Aosong, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement for the defective product.

In order to obtain service under this warranty, customer must notify Aosong of the defect before the expiration of the warranty period and make proper prove for the defect. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Aosong, with shipping charges prepaid. Aosong

- 5 -

Aosong Electronics Co., Ltd.

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Thomas Liu (Sales Manager)

Email: thomasliu198518@aliyun.com , sales@aosong.com



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shall pay for the return of the product to customer if the shipment is to a location within the country in which the Aosong service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Aosong shall not be obligated to furnish service under this warranty

- a) to repair damage resulting from attempts by personnel other than Aosong representatives to repair the product;
- b) to repair damage resulting from improper use or connection to incompatible equipment;
- c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

Special notes: quality problem caused by following reasons is not warranted:

- (1): Damaged by human factor
- (2): Application beyond the using range as stated in product's technical specification
- (3): Damaged by corrosive or acid or alkaline air

- 6 -

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Piezo Buzzer Components



FEATURES

- Voltage rating 12V dc
- Internal circuitry for dc operation
- High output levels
- Operating Temperature -20°C to 60°C
- Flanged mounting buzzer
- Flying lead connections

RS PRO 96dB, Panel Mount Continuous Internal Piezo Buzzer

RS Stock No.: 617-3097



RS Professionally Approved Products bring to you professional quality parts across all product categories. Our product range has been tested by engineers and provides a comparable quality to the leading brands without paying a premium price.

Product Description ATTRIBUTE 1

RS Pro 10mA/20VDC Piezo Buzzer with ABS housing with 28AWG flange mounted wire leads, 96dB sound level, 2.8kHz resonant frequency, PCB mount and continuous tone.

General Specifications

Mounting Type	Panel Mount
Sound Level	96dB
Drive Type	Internal
Tone Type	Continuous
Leads	Flying Lead Connections
Circuit	Internal circuitry for dc operation
Housing Material	ABS

Electrical Specifications

Minimum Supply Voltage	1.5V dc
Maximum Supply Voltage	20V dc
Maximum Frequency	3.3kHz
Minimum Frequency	2300Hz
Supply Current	10mA

Mechanical Specifications

Diameter	41.8mm
Height	16mm
Dimensions	41.8 x 16mm
Weight	15g
Lead Wire	UL1095 AWG 28

Operation Environment Specifications

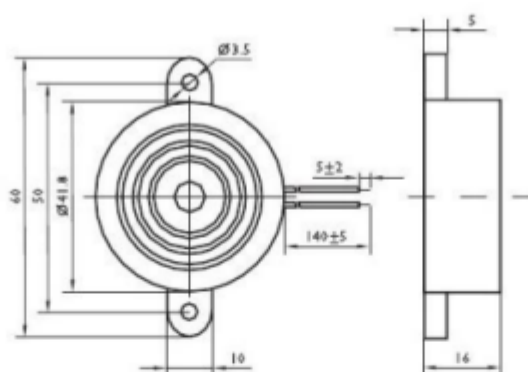
Minimum Operating Temperature	-20°C
Maximum Operating Temperature	60°C

Approvals

Compliance/Certifications	RoHS
---------------------------	------



Dimensions:



Dimensions Unit: mm

Tolerance: $\pm 0.5\text{mm}$

Appendix 3. Red LED datasheet.



NTE3019 **Light Emitting Diode (LED)** **Red Diffused, 5mm**

Features:

- Tapered Barrel T-1 3/4 Package
- High Intensity Red light source with various lens colors and effects
- Versatile Mounting on PC Board or Panel
- T-1 3/4 with Stand-off

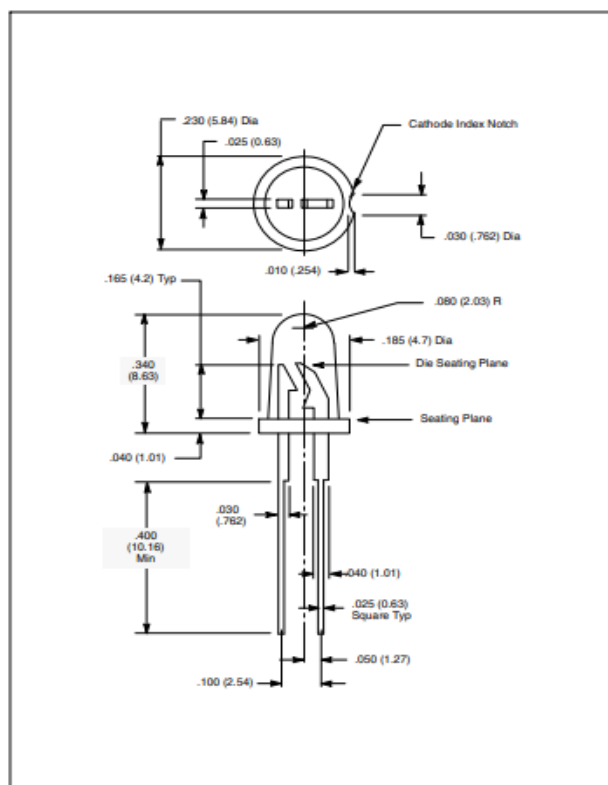
Absolute Maximum Ratings: ($T_A = +25^{\circ}\text{C}$ unless otherwise specified)

Reverse Voltage, V_R	5V
Peak Forward Current (Note 1), I_F	1A
Power Dissipation ($T_A = +25^{\circ}\text{C}$), P_D	180mW
Derate linearly from 25°C	2mW/ $^{\circ}\text{C}$
Operating Temperature Range, T_{opr}	-55° to $+100^{\circ}\text{C}$
Storage Temperature Range, T_{stg}	-55° to $+100^{\circ}\text{C}$
Lead Temperature (During Soldering, 1/16" (1.6mm) from case, 5sec max), T_L	$+260^{\circ}\text{C}$

Note 1. Pulse Width = 1 μ s, 0.3% duty cycle.

Electrical Characteristics: ($T_A = +25^{\circ}\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Luminous Intensity	I_d	$I_F = 20\text{ mA}$	0.9	3.0	—	msd
Peak Wavelength	λ_p	$I_F = 20\text{ mA}$	—	—	660	nm
Spectral Line Half Width	$\Delta\lambda$	$I_F = 20\text{ mA}$	—	20	—	nm
Forward Voltage	V_F	$I_F = 20\text{ mA}$	—	1.65	2.0	V
Reverse Current	I_R	$V_R = 5.0\text{V}$	—	—	100	μA
Reverse Voltage	λ_A	$I_R = 100\text{ }\mu\text{A}$	—	5.0	—	V
Capacitance	C	$V = 0$	—	35	—	pF
Viewing Angle	2 $\theta_{1/2}$	Between 50% Points	—	60	—	degree
Rise Time	t_r	10% – 90% 50 Ω	—	50	—	ns
Fall Time	t_f	90% – 10% 50 Ω	—	50	—	ns



Appendix 4.
Green LED datasheet.

Green LED - T1 (5mm)



RoHS
Compliant

Features

- Standard 5mm round package
- High luminous output
- Water clear lens

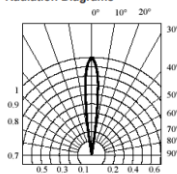
Maximum Ratings at Ta = 25°C

Reverse Voltage (<100µA)	: 5V
D.C. Forward Current	: 30mA
Pulse Current (Pulse Width of 0.1ms, 1/10 Duty Cycle)	: 100mA
Operating Temperature Range	: -25°C to +85°C
Storage Temperature Range	: -40°C to 100°C
Soldering Temperature Dip Soldering	: 260°C for 5s
Soldering Temperature Hand Soldering	: 350°C for 3s

Electrical and Optical Characteristics at Ta = 25°C

LED Chip			Lens Colours	Dominant Wavelength (nm) at 20mA	Luminous Intensity (mcd) at 20mA		Forward Voltage (V) at 20mA		Viewing Angle 2θ ^{1/2} (°)
Material	Emitted Colours	Brightness			Minimum	Typical	Typical	Maximum	
InGaN / Sapphire	True Green	Mega	Water Clear	520	19,500	45,000	3.2	4	15

Radiation Diagrams



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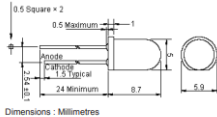
05/02/19 V1.0

Green LED - T1 (5mm)



RoHS
Compliant

Diagram



Dimensions : Millimetres

Part Number Table

Description	Part Number
Green LED - T1 (5mm)	MC703-1061

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26

James Hammond

Appendix 5. Yellow LED datasheet.

LED Yellow, 5mm

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Features:

- Built-in IC chip, flashes lamp on and off to attract attention
- Operating voltage range : 3V to 10V DC
- 1/4 duty cycle
- Blinking frequency : 2.4Hz (V_{as} = 5V)
- Frequency tolerance : 20%

Specifications:

Dice material	: GaAsP on GaP
Emitted colour	: Yellow
Lens colour	: Yellow Diffused
Peak wavelength	: 587nm
Viewing angle	: 45°
Luminous intensity (IV)	: 9.8mcd

Absolute Maximum Ratings (T_a = 25°C)

Parameter	Maximum	Unit
Continuous Forward Current	30	mA
Derating Linear From 50°C	0.4	mA/°C
Reverse Voltage	5	V
Operating Temperature Range	-40°C to +85°C	
Lead Soldering Temperature [4mm (0.157 inch) from body]	280°C for 5 Seconds	

Electrical/Optical Characteristics at T_a = 25°C

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test
Luminous Intensity	I _v	-	9.8	-	mcd	I _f = 20mA
Peak Emission Wavelength	AP	-	587	595	nm	Measurement at Peak
Dominant Wavelength	AD	-	590	-	nm	I _f = 20mA
Operating Voltage	V _{as}	3	5	10	V	-
Blinking Frequency	F _{as}	2	2.4	2.8	Hz	-
Reverse Current	I _r	-	-	100	μA	V _r = 5V

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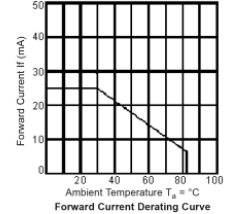
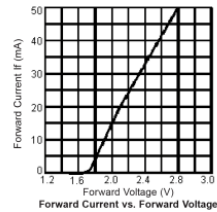
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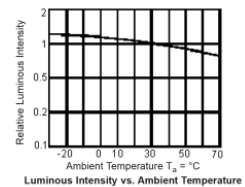
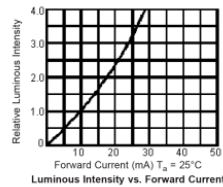
LED Yellow, 5mm

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Yellow (GaAsP/GaP) AP = 587nm



Yellow (GaAsP/GaP) AP = 587nm



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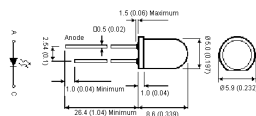
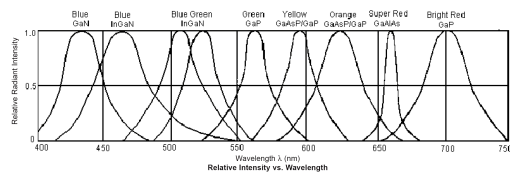
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Page <2>

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LED Yellow, 5mm

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Dimensions : Millimetres (Inches)

Part Number Table

Description	Part Number
LED, Flashing, 5mm, Yellow	MCLF0587YD

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Appendix 6.
Orangepip Kona328 board datasheet.



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

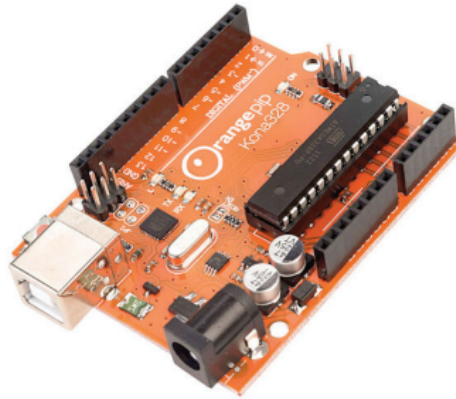
The Kona328 can be powered via the USB connection or with an external power supply. The power source is selected automatically.

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.

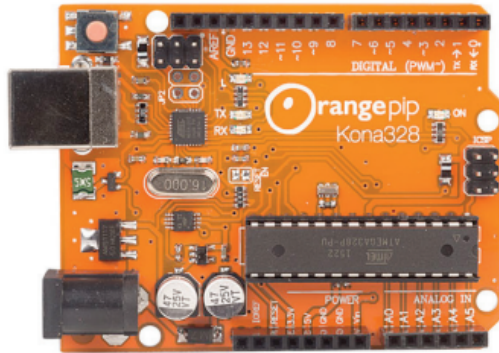
Page 1 of 3

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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 OrangePi 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.

Page 2 of 3

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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.



Page 3 of 3

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