# TEMPERATURE INDICATOR CIRCUIT FOR BETTER COMFORT AND ENERGY EFFICIENT AIR CONDITIONING SYSTEMS WITH SAFETY FUNCTION USING ATMEGA328


**EC6020: EMBEDDED SYSTEMS DESIGN – PROJECT**

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

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**TITLE OF THE PROJECT:**

Temperature Indicator Circuit for Better Comfort and Energy Efficient Air Conditioning Systems Using Atmega328

**ABSTRACT:**

According to the International Energy Agency (IEA), electricity consumption for air conditioning will be the main trigger for the increase in world electricity demand in the next 2050. Air conditioning becomes inefficient and uncomfortable Due to the inability to set the most efficient and best comfortable temperature. Air conditioners consume more power when the outside temperature is high. Air Conditioners are depending on the ambient air to remove heat. When the outside temperature is high, the air conditioner can't remove heat effectively. Thus, the air conditioner may struggle to provide sufficient and energy efficient cooling. If the outside temperature is below the air conditioning limit, we may experience the following consequences. The unit's inner coils will freeze. The lubricating fluid will thicken, and the unit will not function properly and may ultimately damage the air conditioner. In this paper, a design for a Temperature Indicator Circuit for Better Comfort and Energy Efficient Air Conditioning Systems with safety function that can indicate the proper temperature to set the Air conditioner is proposed and discussed. The system is built around two sensors that can measure the both inside and outside temperatures.

**Keywords**: HVAC, Temperature Sensor (AM2302), Energy Efficient, LCD Display, atmega328

**INTRODUCTION:**

An air conditioner not only consumes more power during hot days, but it also may not provide sufficient and efficient cooling for a house. We all know that when the outside temperature is high, the air conditioner needs to work harder to cool the room. Therefore, it consumes more power. But it is more than that.

The power consumption of the air conditioner is associated with the efficiency of the air conditioner. The efficiency of the air conditioner is measured by the coefficient of performance (COP). The higher the COP, the higher the efficiency, and thus, the lower power consumption.

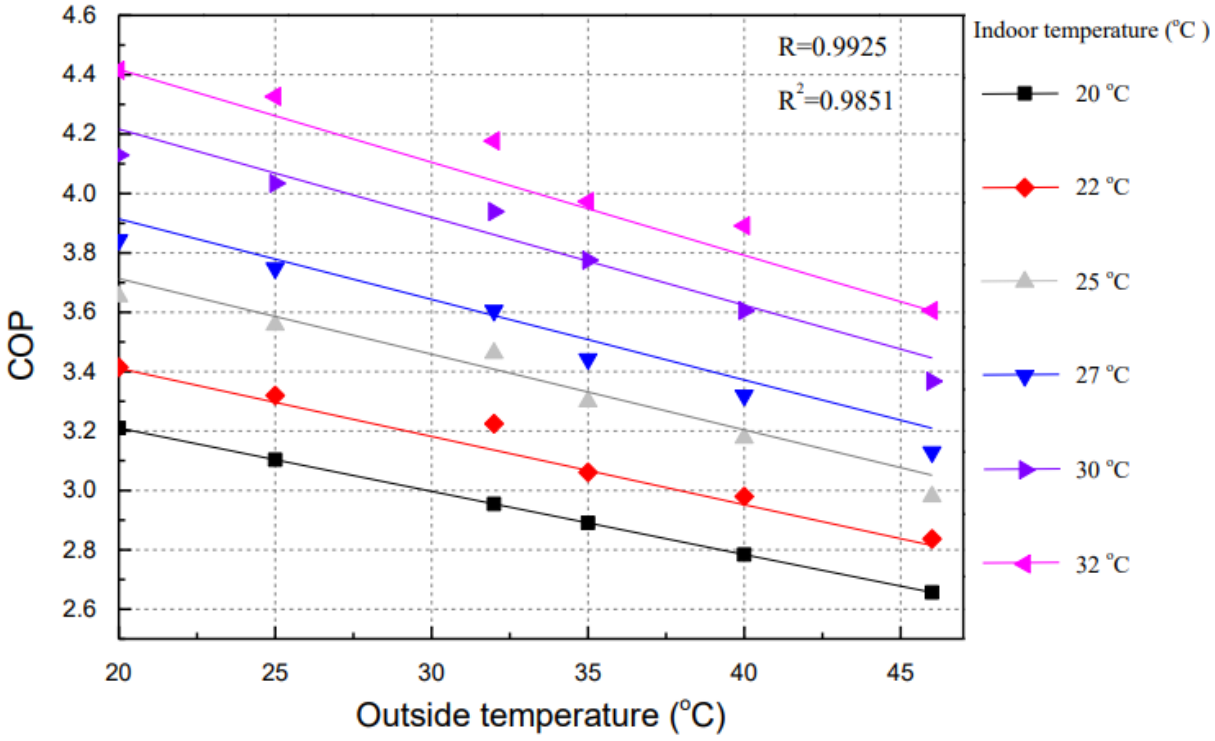


*Figure 1 : COP of a split air conditioner as a function of working conditions*

From studying the above graph, we can see that as the outside temperature increases, the COP decreases. Hence, the outside temperature is exponentially affecting the COP and power consumption of the air conditioner. Besides, it is noticed that setting your air conditioner at around 25°C is the best for energy efficiency.

In order to measure both outside and inside temperature and suggest a best cooling temperature of air conditioning system, an embedded system is created using the ATmega-328 Microcontroller. By an LCD display suggested temperature is shown for the customer. If the outside temperature goes down beyond the inside temperature the relay is turned on and turn off the AC system. This will protect the whole AC system. The circuit is inexpensive and simple to implement in residential areas for comfortable and energy efficient Air Conditioning System with safety function.

**AIMS AND OBJECTIVES:**

This project's aim is to design and build an ATmega328 microcontroller-based both inside outside temperature detector and indicating system for setting the temperature of Air conditioner.

The following are the project's objectives:

- ✓ To offer a novel method for suggesting temperature in both cold and hot outside temperatures
- ✓ To create an embedded system with high reliable, cost-effective and user friendly.

## LITERATURE REVIEW:

### Related works:

[1] X. Xu et al. reviewed on temperature and humidity control methods applied in small- and medium-sized buildings and summerized about hardware-based decoupled (HWBD) control and software-based decoupled (SWBD) control methdes. Also this paper reviwed about Principles, merits, and obstacles of these two methods and discussed about Potential benefits of energy saving and better control performance brought by combining the two methods are discussed. [2]J. Wang et al. reviwed about a model predictive control (MPC) strategy of hybrid cooling system, i.e. ventilation cooling and air conditioner cooling, for telecommunication base stations. To handle the discontinuity and nonlinearity involved with the hybrid cooling system model, a discrete particle swarm optimization algorithm is adopted. As well as, the performance due to model mismatch is also investigated by using various COP values. [3] M. R. Levine et al invented an automatic temperature adjusting system for an air conditioner room. The automatic temperature adjusting system for the air conditioner room was made simple in operation and was capable of monitoring the temperature of the human body at any time in the air conditioned room and transmits the corresponding signals to the air conditioner in time

### Embedded System:

a. **AM2302 Temperature and Humidity sensor**

   AM2302 Temperature & Humidity Sensor features a temperature & humidity sensor with a calibrated digital signal output. It uses exclusive digital-signal-acquisition technique and temperature & humidity sensing technology; it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

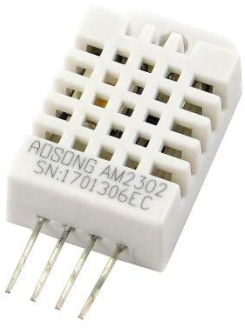


*Figure 2 : AM2302 Temperature and Humidity sensor*

**b. LCD (Liquid Crystal Display)**

The most basic and commonly used LCDS are the 16×2 because they are cheap, easy to program and can display wide range of characters. This is a 16-pin device which displays 16 × 2 characters. In this project the 16×2 LCD is used to display the state of heater or fan and the AM2302 readings.


*Figure 3 : 16 ×2 Liquid Crystal Display*

**c. ATmega328**

The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core.

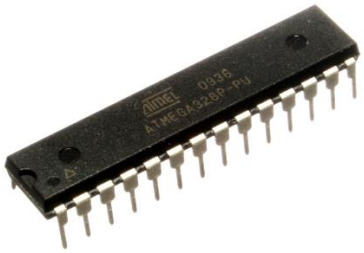


*Figure 4 : ATmega328 Controller*

**METHODS AND MATERIALS:**

In this project, Temperature is measured using AM2302 sensors. One AM2302 sensor is keep in outside on the room and Other AM2302 sensor is keep in inside to measure the temperature. Then, the measured temperature is identified by the microcontroller and temperature readings are sent to the 16x2 LCD display. If

**Outside temperature > Inside temperature** - LCD display will show the suggested temperature to the consumer for setting the Air conditioner temperature.

**Outside temperature < Inside temperature** – Relay will be activated and turn off the Air conditioner for protecting the Air conditioning system components.

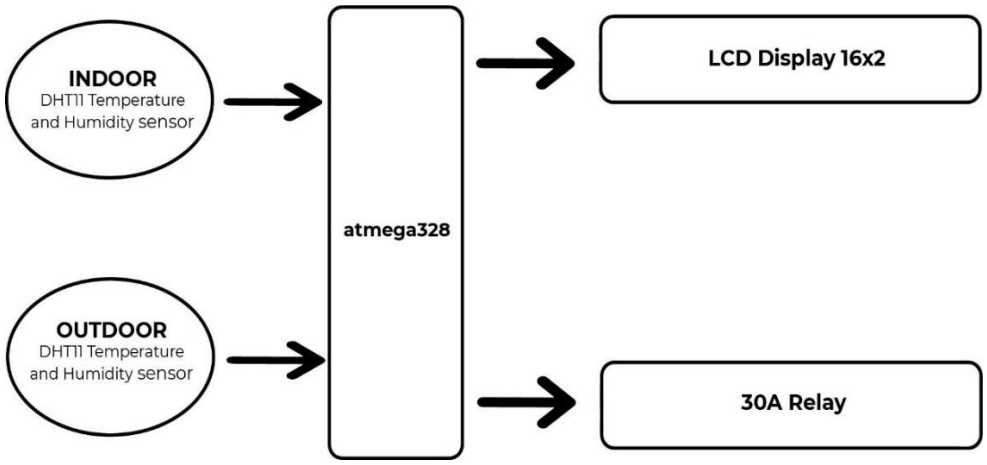


*Figure 5 : Block diagram of temperature indication and control system*

The ATmega328 microcontroller, AM2302–Temperature and Humidity Sensors and Relay Module and 16x2 LCD Display are the system's main components.

First, we are going to build the test circuit using Arduino Uno and the following hardware elements are necessary for the design of Temperature Indicator Circuit for Air Conditioning System. Arduino Uno along with USB cable, 12V Power supply, 2xAM2302 Temperature and Humidity Sensor, Relay Module, 220 Ohm Resistors, LCD 16x2 Display, Rotary Potentiometer - 10k, Breadboard, Jumper wires.

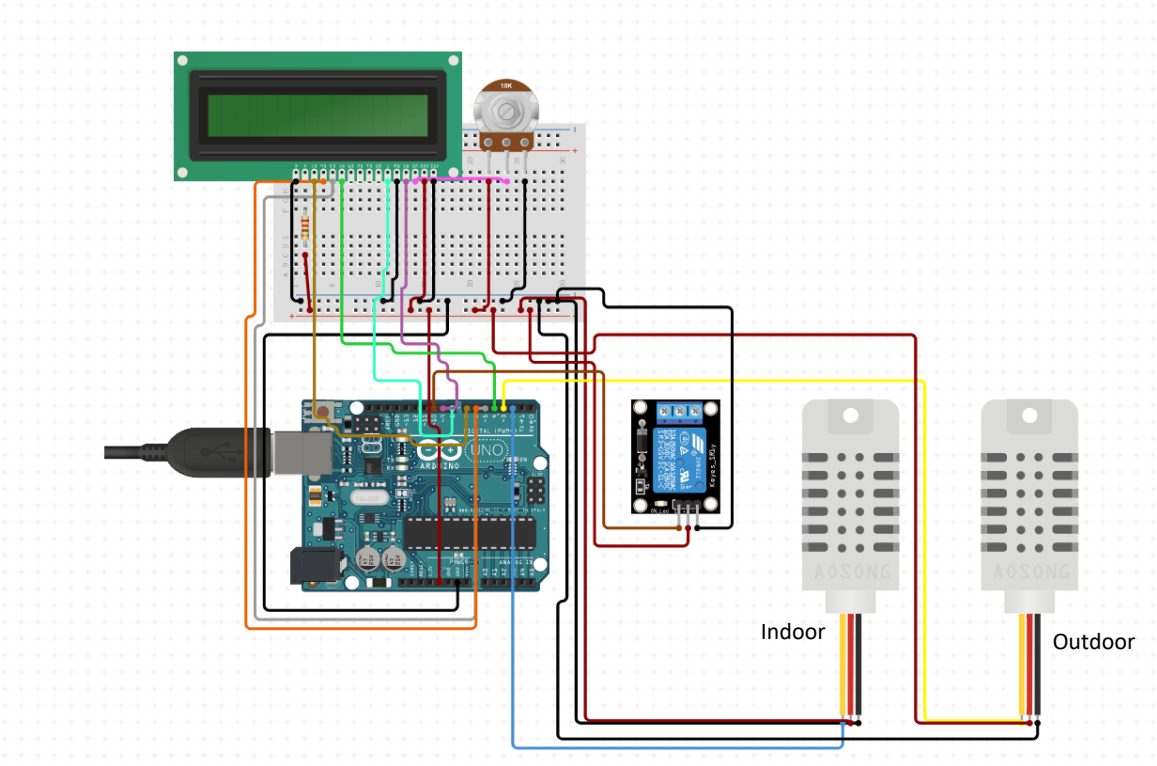


*Figure 6 : Circuit diagram of AM2302 sensor connected with Arduino UNO.*

After Testing the system implementation works properly and fixing the errors and bugs in the code, we can Implement the circuit by removing the Arduino UNO board.

For that we can replace the Atmega328 microcontroller for build up the system.

For implement that circuit, we used 5V Power supply, 2xAM2302 Temperature and Humidity Sensor, Relay Module, 10K Ohm Resistor, 220 Ohm Resistors, LCD 16x2 Display, 16MHz Crystal, 1uF Electrolytic capacitor, 100nF Ceramic capacitor, 22pF Ceramic capacitor, Rotary Potentiometer - 10k, Breadboard, and Jumper wires.

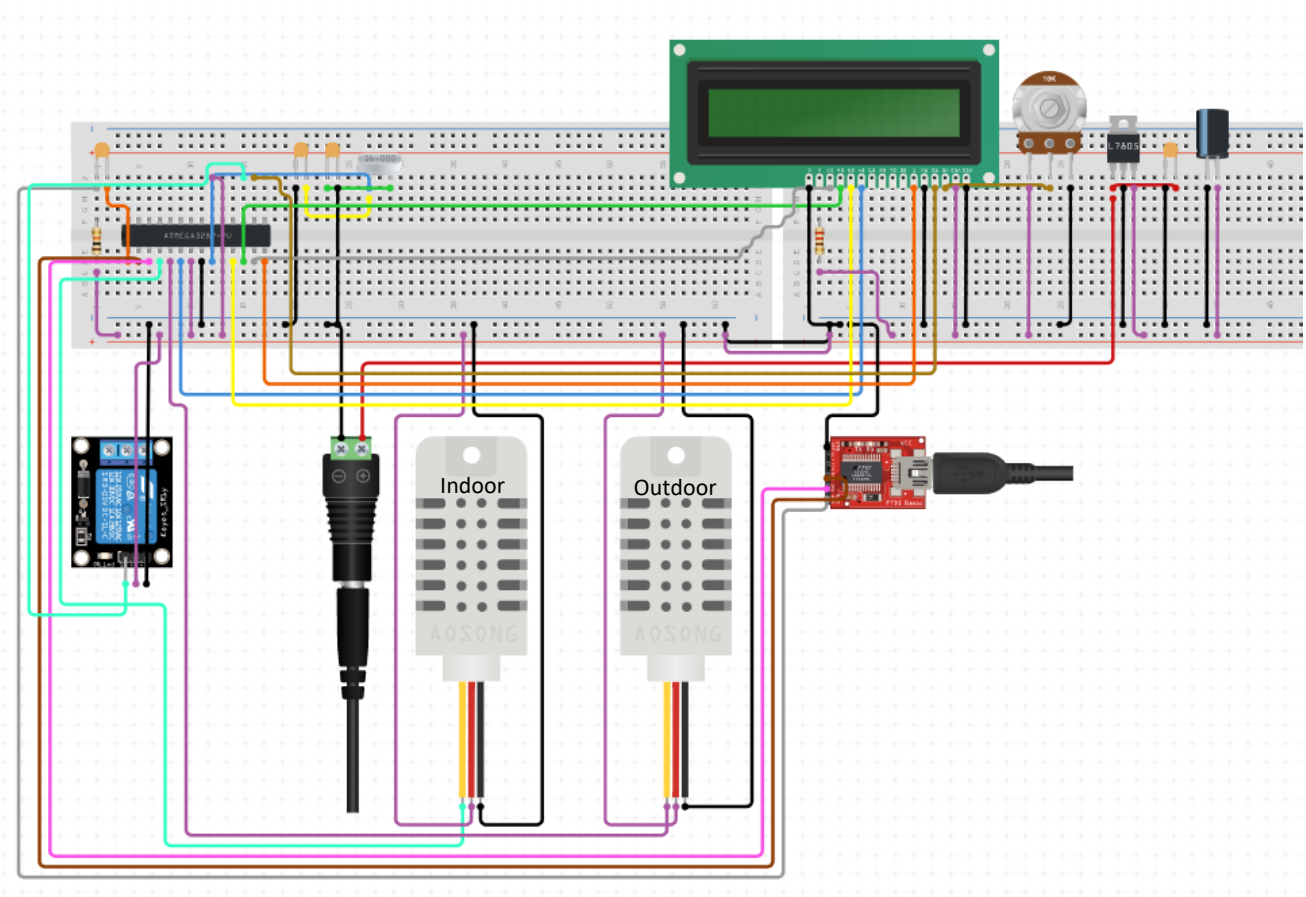


*Figure 7 : Implemented Circuit using atmega328*

The outdoor sensor is kept on outside of the room for measuring the temperature. Atmega328P microcontroller is programmed using C language. Code is uploaded using Atmel Studio 6.0

**BUDGET:**

*Table 1 : The estimated budget of the project*

| **Expenses** | **Unit** | **# of Units** | **Unit rate (USD)** | **Cost (USD)** |
|---|---|---|---|---|
| **Sensors** | | | | |
| Temperature and Humidity Sensor (AM2302) | per item | 2 | 1.38 | 2.76 |
| **Subtotal sensors** | | | | **2.76** |
| | | | | |
| **Modules** | | | | |
| Arduino Uno | per item | 1 | 12 | 12 |
| Relay Module | per item | 1 | 1.73 | 1.73 |
| **Subtotal Modules** | | | | **13.73** |
| | | | | |
| **Wiring** | | | | |
| 28AWG Sheathed Wire Cable Line 3 | per meter | 10 | 0.7 | 7 |
| Jump wire | per item | 30 | 0.1 | 3 |
| **Subtotal Wiring** | | | | **10** |
| | | | | |
| **Other Equipment** | | | | |
| 16x2 LCD display | per item | 1 | 10 | 10 |
| Breadboard | per item | 1 | 5 | 5 |
| Resistors and Capacitor | per item | 6 | 0.1 | 0.6 |
| Rotary Potentiometer | per item | 1 | 0.8 | 0.8 |
| Cristal Oscillator | per item | 1 | 0.1 | 0.1 |
| Power supply 12V | per item | 1 | 2 | 2 |
| **Subtotal other equipment** | | | | **18.5** |
| | | | | |
| **Total Expenses** | | | | **44.99** |

Note - All the values are calculated using USD.

- Total expenses in USD - $44.99
- Total expenses in SLR – RS. 15840.00

**TIMELINE:**

*Table 2 : The Timeline of the Project*

| ALLOCATED WORK | WEEK | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| Topic Selection | | | | | | | | |
| Building Infrastructure | | | | | | | | |
| Feasibility Study | | | | | | | | |
| Literature Review and Proposal Writing | | | | | | | | |
| Basic Initial Prototype Design and Error Correction | | | | | | | | |
| Software Implementation and Final Evaluation | | | | | | | | |
| Final Presentation | | | | | | | | |

**SIGNIFICANT OF THE PROJECT:**

This project is led to make more energy efficient and more comfortable temperature for living. There are many advantages in this system and we can use this system in different residential, commercial, and industrial applications.

**Advantages:**

- ✓ Cost effective.
- ✓ Energy Efficient and convenient
- ✓ User friendly

**Application:**

- ✓ HVAC almost consumed half of the energy in buildings and 20% of the overall national energy consumption. Therefore, this small system will help to decrease the energy consumption of ACs in residential and commercial buildings
- ✓ This system is very useful in greenhouse to ensure the necessary temperature inside the greenhouse for better crops.

**CONCLUSION:**

Air-Conditioning (HVAC) system are to help maintain indoor temperature to provide thermal comfort. Mostly the consumer does not care about the outdoor temperature for controlling the air

conditioning temperature. That will be led to more energy consumption, bad thermal comfort and safety of the air conditioning systems. From this small, cost effective circuit we hope to minimize above shortcomings.

For the future implementations we can develop the circuit which works automatically and remote controllable for maximize the user's easiness.

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