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An Electrical and Fire Safety Solution for Bathroom Appliances

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Abstract: The article presents an electrical and fire safety solution for bathroom equipment thanks to an additional smart module [6], [7] to monitor water, power, voltage leaks and temperature over the threshold allowed. The article also presents an effective way of using the bathroom device when pairing smart module with IoT [2],[3], [4], [5] to increase the utility of the device for effective remote monitoring and controlling of the device. Thanks to the smart module, bathroom equipment will help prevent people from the risk of fire in high-rise buildings, mostly caused by bathroom equipment.

Keywords: Bathroom equipment, smart module, IoT pairing, power monitoring.

I. INTRODUCTION

A. Current status of electric safety equipment and fire safety in bathrooms

Currently, electrical safety devices for bathroom equipment have been studied and applied in many Vietnamese families. However, the application of both electrical and fire safety equipment is still limited and not popular due to its high cost. Equipment is mainly imported from abroad.

Electrical safety equipment, fire and explosion are widely used and bring economic efficiency and ensure safety for users thanks to the electric detector warning device, the warning of fire risk, electric shock.

B. Hot water heater and appliances using electricity in the bathroom

A heater is a device used to heat water automatically:

Indirect heater is a heater that contains a container and uses indirect heating. The heat rod of the flask is not in direct contact with water but is covered with an insulating layer that conducts heat outside.

The direct heater is a heater with no tank or a very small, insignificant capacity tank. Water after being heated will be heated and discharged to use immediately.

Infrared heater is a type of heater that uses infrared rays to heat water. When water passes through the quartz tubes in the flask, it will be shone by infrared rays and heated immediately in a very fast time.

C. The effect of hot water heater's risk on users

1. Leaking electricity of the hot water heater

One of the causes of electric leakage in the heater is because the user has a habit of wanting to shorten the time so the heater plugs in 24/24 when not being in use and while taking a shower. Because many users subjectively trust the relay system to disconnect power, without knowing the real operation of this relay is just adjusting the temperature, that is when the water temperature is low, the relay will provide electricity to heat water to the required temperature, disconnect the power when the water temperature is too high and there is no function to prevent electricity leakage. All-day power supply to such a heater for a long time will result in a deformation of the resistance wire (or mayso wire) and the insulation of the heater, causing the mayo wire to touch the cover or the insulation pad being damaged by operation overload, thus causing a very dangerous leakage of electricity out.

The second cause of electric leakage in the heater is due to corrosion in the process of using the insulating layer of the burner. Because the heater operates based on the temperature of the heating element, when heating water, the temperature of the heating element is very high, in a long time, this insulation will corrode causing electric leakage to the water source.

2. The hot water heater on fire.

The reason is that the explosion of the heater can be caused by the temperature control sensor, thermal switch and safety valve closed tightly due to long-term dust and dirt. Normally, when the temperature in the tank reaches 80 degrees C, the thermal switch will automatically disconnect the heating bar. However, due to the failure of the sensor and the temperature controller, the water kept boiling more than 80 degrees Celsius and produced a lot of steam, causing the pressure to increase. After only about 20 minutes, the vessel exploded because it was beyond the bearing capacity of the cylinder if not detected in time.

II. MODULE DESIGN

The research team presents electrical equipment used in the bathroom with the development of an electrical safety and fire safety module design for bathroom equipment with the following functions:

- Control the operating capacity of the device, limit the warning when the device operates over the maximum capacity provided by the manufacturer.
- Control the temperature of the equipment, for the hot and cold water tank to control the temperature of the water tank, the heater controls the heat within the safety limit of the device.

Protection against electrical leakage to the outside

- Handling when there are dangerous factors: power off, warning, etc

A. Microcontrollers

The team uses Atmega 2560 and Atmega 328 [1] suitable for the number of devices used in the bathroom. Atmega2560 has a larger number of I / O than Atmega328 so it is used in case of needing protection for multiple devices.

B.Functional block diagram

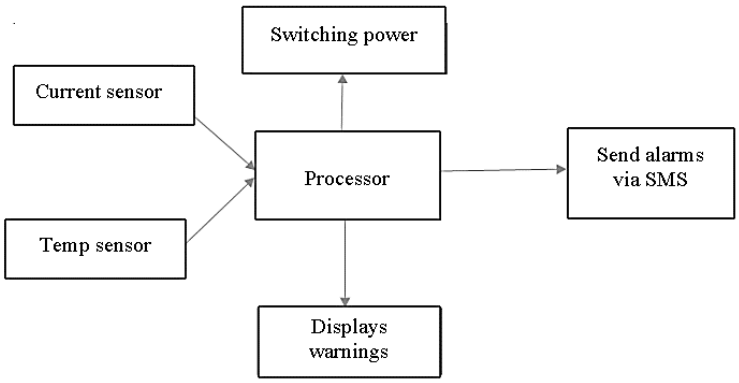


Fig 1. Diagram of function blocks

The Atmega328 (or Atmega2560) microcontroller acts as the central processor [1], receiving information and controlling the operation. Information gathering unit includes: current sensor and temperature sensor help processor make decision on operating indicator such as power - off and alarming.

Several used sensors

Line sensor: A current sensor is a device that detects the current in a wire and produces a signal that is proportional to that current. The generated signal can be either voltage or current, or even a digital output. The generated signal can then be used to display the measured current in the ammeter or can be stored for further analysis in the data acquisition system or can be used for control purposes.

Fig 2. Line sensor

Indirect current sensors are mentioned in the paper by placing a wire around a current carrying conductor, a voltage induced across the wire line is proportional to the current. This sensing method is used for large load currents to meet the requirements of the problem.

III. EXPERIMENTAL MODULE

To ensure a high-quality product, diagrams and lettering MUST be either computer-drafted or drawn using India ink.

Figure captions appear below the figure, are flush left, and are in lower case letters. When referring to a figure in the body of the text, the abbreviation "Fig." is used. Figures should be numbered in the order they appear in the text.

Table captions appear centered above the table in upper and lower case letters. When referring to a table in the text, no abbreviation is used and "Table" is capitalized.

A. Functional block diagram

The central processor plays a major role in the device. The number of inputs / outputs depends on the requirements for the safety indicators to be collected and the number of control devices. The processor is fully designed with components that can be operated independently, easily customized with each requirement. The basic components include: power block, oscillator block, I / O communication block and other stable operation components (filter circuit). The team integrated the components onto the same control circuit.

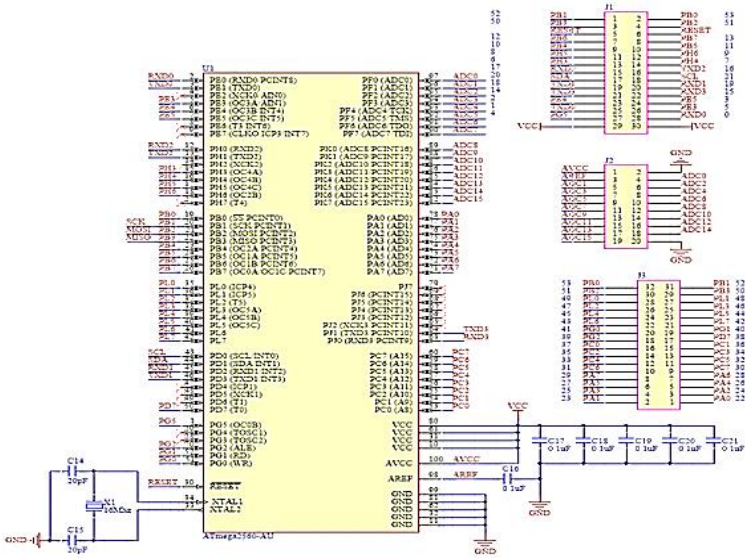


Fig 3. Central processor principle

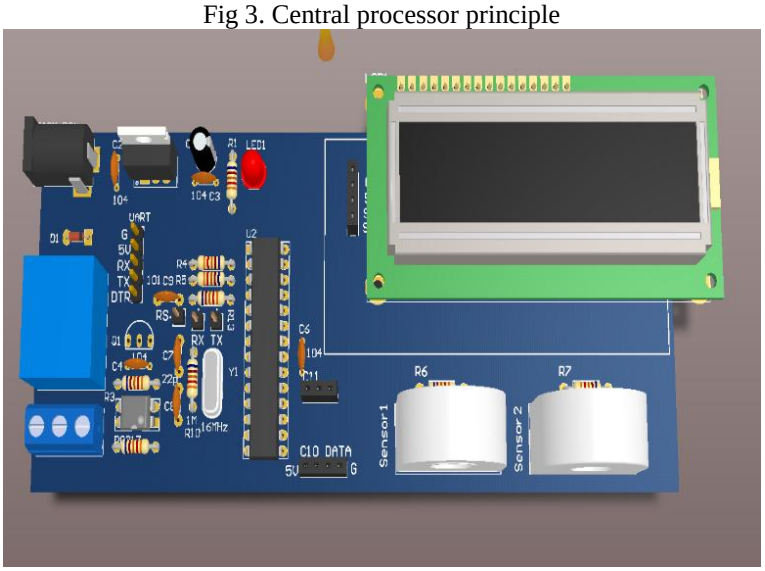


Fig 4. Integrated control circuit

In the integrated circuit, the team introduces the Atmega328 microprocessor, with the advantages of compactness, full of value collection and operation control. Control circuit compatible with temperature sensor and current sensor. It displays current status information and controls the device's operation.

B. Survey results

The research team conducted to survey the current measured value to adjust the sensor.

- Investigation on resistive loads
- Investigate with loads with power ranges from 50w - 2000w
- Draw the relationship characteristics

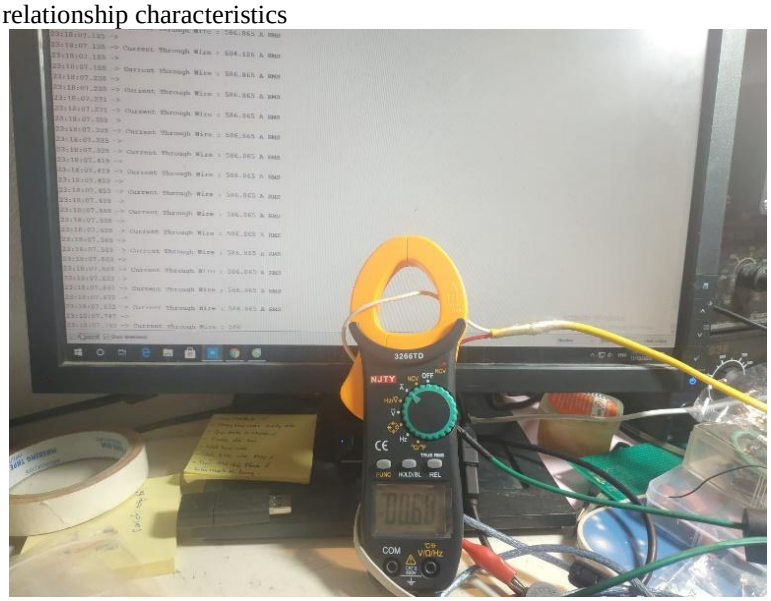
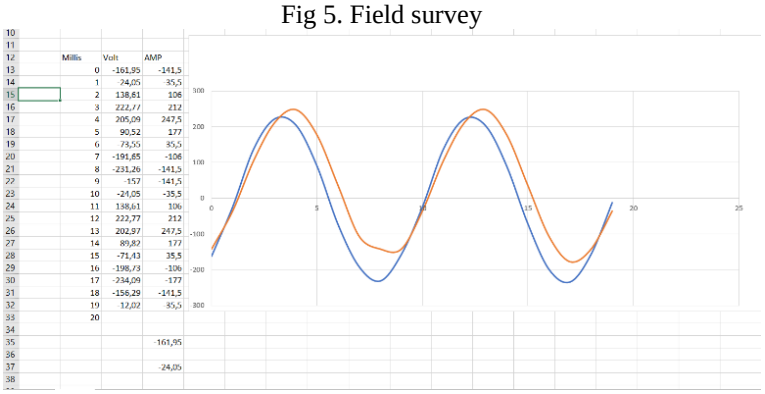


Fig 5. Field survey



Millis	Volt	AMP
0	-161,95	-141,5
1	24,05	-35,5
2	138,61	106
3	222,77	212
4	205,09	247,5
5	90,52	177
6	73,55	35,5
7	-191,65	-106
8	-231,26	-141,5
9	-157	-141,5
10	-24,05	-35,5
11	138,61	106
12	222,77	212
13	202,97	247,5
14	89,82	177
15	-71,43	35,5
16	-198,73	-106
17	-234,09	-177
18	-156,29	-141,5
19	12,02	-85,5
20		
		-161,95
		-24,05

Fig 6. Measured data

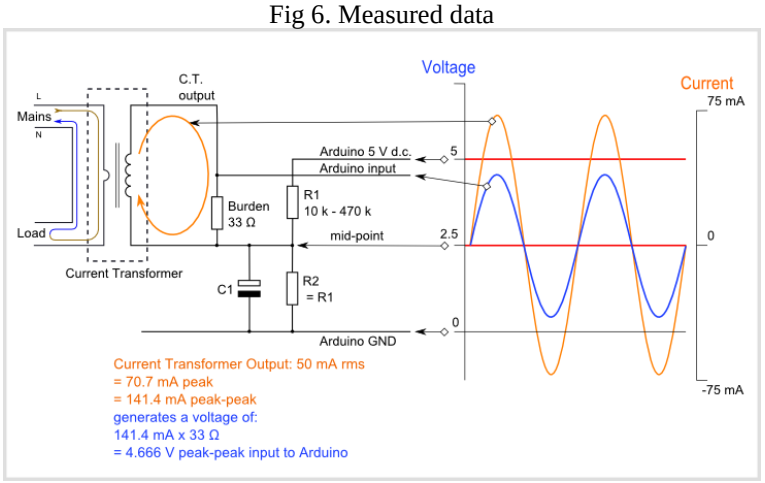


Fig 7. Comparison with theory

IV. CONCLUSION

After designing and making printed circuits, the team put it to the test to test the device's performance as well as editing, overcoming some disadvantages to make the next improved version. After the survey, the

team established the timeline to read the sensor value in each measurement cycle, and fixed the sensor sample parameter and also investigated the stability of functional components.

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