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IOT Based Real Time Transformer Protection System

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Abstract:*Generally,a distribution transformer is used for stepping down the voltage to a level required by the consumer. The additional attachments include current sensor, voltage measuring circuit, S PS T relay, a resistive load. This paper deals with a system that can automatically monitor and control a 1KVA distribution transformer by interfacing ATmega328. The transformer parameters current and voltage are monitored using current sensor and voltage measuring circuit respectively and the values are interfaced to ATmega328. They are further controlled automatically using relay tripping circuit.*

Keywords: *IoT, ATmega328, Transformer.*

I. INTRODUCTION

Our area of work is Power System. On July 30 2012, parts of north eastern India suffered a massive blackout due to the mishandling of relay. This manmade error resulted in line stress that spread vigorously. Thus the total grid system got deteriorated leading to a heavy blackout. So to get rid of these issues, we are designing a system that can monitor and control a transformer without any interruptions. This system can be expanded and can be used for various industrial purposes , industrial monitoring stations , substations , power plants . It reduces human effort and increases accuracy.

In this real time model, a trans former of 1KVA capacity with a lamp load of 1000W is us ed. The load is connected to a current sensor and a voltage measuring circuit for measuring the consumption of current and voltage. The values of the respective sensors are interfaced with the microcontroller. The microcontroller used in this system is an ATmega328 controller. These values are in turn uploaded in the cloud network. The cloud network consists of a database which contains a table showing voltage, current, date and time. These values are used for future reference. On s witching the load, if the current exceeds the preset current value, an alert will be sent to the user. The primary tripping circuit will automatically isolate the load. The tripping circuit operations are set in motion using Relay circuit. The user has an option to trip the whole load if necessary in case of any emergency through IoT. The advantages of this system are that the tripping circuit can be operated at any load conditions. Since this system is connected with the internet it can be operated from anywhere at any time. The only thing that needs s to be ensured is to keep the system online always. This system is structured in a cost effective manner and hence it can be used for both domestic as well as industrial purposes.

II. SYSTEM LAYOUT

1.Blockdiagram

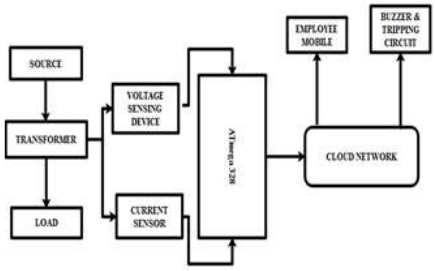

Fig.1: Overall block diagram

2. Trans former

The trans former is a s tatic device (no moving parts) that cons is ts of one, two or more windings which are magnetically coupled and electrically s eparated with or without a magnetic core. It trans fers the electrical energy from one circuit to the other by electromagnetic induction principle. It can either decreas e or increas e the voltage and current by the us e of trans former in AC circuits bas ed on the requirements of the electrical equipment or device or load. The winding connected to the AC main s upply is c alled primary winding and the winding connected to the load or from which energy is drawn out is called as s econdary winding. Thes e two windings with proper ins ulation are wound on a laminated core which provides a magnetic path between windings .

The trans former us ed in our s ys tem is a1KVA distribution type trans former. The trans former monitoring and controlling is done us ing the microcontroller ATmega328.

3. ATmega328 controller

The Arduino Uno is a microcontroller board bas ed on the ATmega328. It has 14 digital input- output (I/O) pins which cons is ts of 6 PWM outputs,
6 analog inputs , a 16 MHz crys tal os cillator, an
USB connection, a power jack, an ICSP header, and a res et button. It can be s imply connected to the computer with an USB cable or power it with an AC-to-DC adapter to get initiated.

The pin configurations of ATmega328:
• Vin: The input voltage is s upplied through this pin or via power jack.
• 5V: The 5V either comes from Vin via an on -
board regulator or can be s upplied by an USB or another regulated 5V s upply.
• 3.3V: A 3.3 volt s upply is generated by the on -
board regulator.
• GND: This is the ground pin.
• Pin 0 (RX) and 1 (TX): Thes e pins are us ed to receive (RX) and trans mit (TX) TTL s erial data. Thes e pins are connected to the corres ponding pins of the ATMEGA 328 USB-to-TTL Serial chip. .
• External Interrupts 2 and 3: Thes e pins can be
configured to trigger an interrupt on a low value, a ris ing or falling edge or a change in value.
• PWM 3, 5, 6, 9, 10 and 11: Thes e pins provide
8-bit PWM output with the analog Write ( )
function.
• SPI 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK): Thes e pins s upport SPI communication.
• LED 13: There is a built-in LED connected to
digital pin 13. For high value, the LED turns ON, and for low value, the LED turns OFF. (Fig.2)

Fig.2: ATmega328 microcontroller

4. Current sensor

The current sensor used in our system is an ACS712 sensor, which can accurately detect AC or DC current. The maximum AC or DC that can be detected can reach 30A, and the present currents signal can be read via analog I/O port of Arduino. *(Fig.3)*

- **Supply Voltage:** 4.5V~5.5V DC
- **Measure Current Range:** ±30 A

Fig.3: Current sensor ACS712

5. 12V Potential Transformer

The purposee of the potential transformer is to step down the 220V AC ssupply into 12V which is required by the voltage measuring circuit. This stepped down voltage is further ssupplied to relay driver circuits. *(Fig.4)*

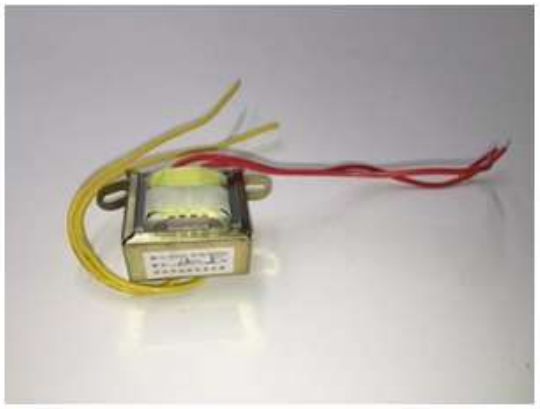

Fig.4: Potential transformer (12v)

6. Relay circuit

In our project, two relay circuits are used. One circuit is to trip three saerially connected loads and the other circuit is used to trip ssingly connected load. The following components are used in relay driver circuit:

- SPST 12V 10A relay
- SPST 12V 5A relay
- Transistor
- LED
- Resistor

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SPST 12V 10A relay: This relay is a single channel SPST relay. For this relay 12V supply must be given. The maximum current limit is 10A. This relay is placed in the circuit which trips the three serially connected loads.

SPST 12V 5A relay: This relay is also a single channel SPST relay. This relay also requires 12V supply. The maximum current limit is 5A. This relay is placed in the circuit which trips the singly connected load.

Transistor: A transistor is a device which is commonly used to amplify current. BC547 transistor is used in our relay circuit. It is an NPN bi-polar junction transistor. It is a three terminal device with emitter (E), base (B), and common (C). High current transistor SL100 is also used to switch power relays. *(Fig.5)*

Fig.5: Relay circuit

7. Power Supply Kit

The power supply circuit is used to supply 5V to the Arduino board. The components involved in this circuit are:

- IN4007 diode
- IC 7805 regulator
- Capacitor
- LED
- Resistor

IN4007 diode: A diode is a device which allows current to flow in one direction. For IN4007 diode, the maximum current carrying capacity is 1A and can withstand peaks up to 30A. They are commonly used as current flow regulators, to prevent reverse polarity problem and as a protection device.

IC 7805 regulator: Voltage regulator IC's are the IC's that are used to regulate voltage. IC 7805 is a 5V Voltage regulator that restricts output voltage to 5V. There are three pins in IC 7805. Pin 1 takes the input voltage, pin 2 takes the ground and pin 3 takes the output voltage.

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Capacitor: In the power supply circuit, a 1000uf 25V capacitor is used. It is used as a charge storage device.

LED and Resistor: Led is used to indicate that power supply board is working properly, resistor is used to prevent LED getting damaged. *(Fig.6)*

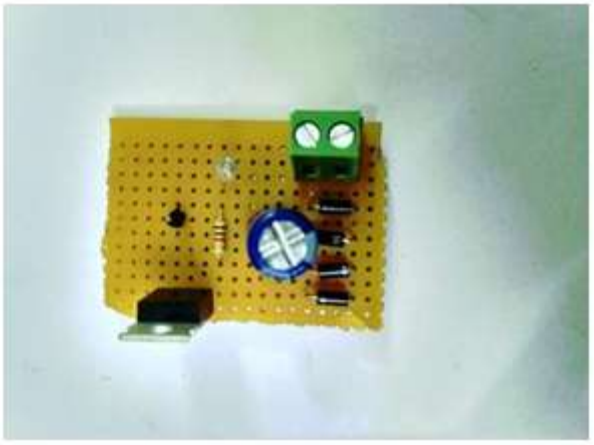


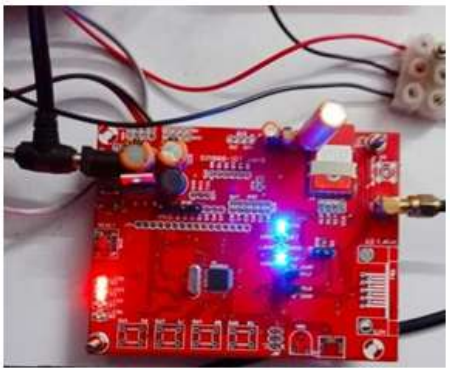
Fig.6: Power supply circuit

8. Voltage measuring circuit:

This circuit is used to sense the A.C voltage. The supply is provided by 12V potential trans former. The components used in the voltage measuring circuit are:

9. IoT board

This board contains a sim slot and receiver for transmitting and receiving the information. Bas ically this board has the capability of supporting up to 3G network. This board consists of integrated programs for separate server, login details, database and to give warning signal to the user. *(Fig.8)*



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IN4007 diode

- Zener diode
- 1K potentiometer
- 1000uf Capacitor
- Resistor

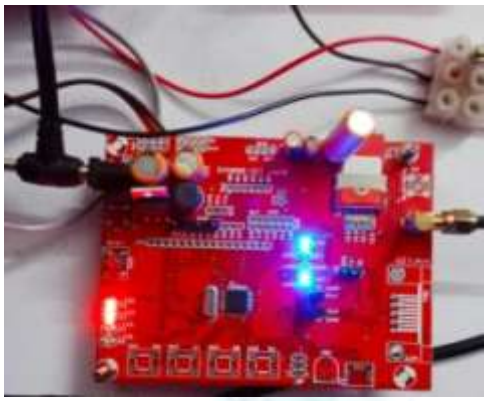

Fig.8: IOT Board

Zener diode: A Zener diode is a special type of device designed to operate in the Zener breakdown region. Zener diode allows current to flow not only from anode to cathode, but also in reverse direction. They are used to regulate voltage that ripples from supply voltage.

1K potentiometer: A 1K potentiometer is a three terminal resistor namely input (I), output (O) and source (E). These terminals be like rotating contact that forms adjustable voltage divider. They are varied and kept in 2.4. *(Fig.7)*

Buzzer is used to provide warning signal when the current value exceeds the preset value. *(Fig.9)*

Fig.9: Buzzer

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III. WORKING

a. Connections are made as per the block diagram.
b. Resistive load is connected with the transformer along with the whole monitoring and controlling unit.
c. When the load is switched on, the corresponding voltage and current values are measured using the respective

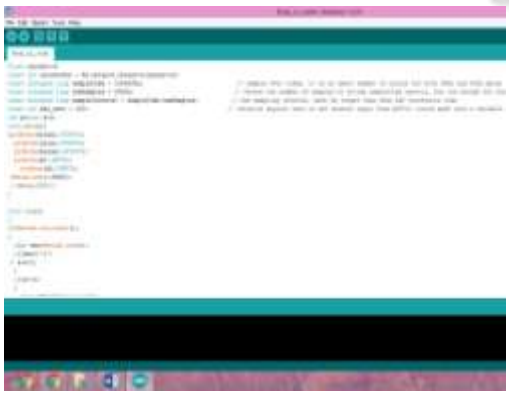
measuring circuits and these values are interfaced to the ATmega328 controller.

d. These values get updated in a server named www.iotcloudservers.com and they are used for future reference.
e. On continuous switching of load, if the current value exceeds the preset value, a buzzer signal is generated. This is a warning signal.
f. Similarly on subsequent increase in load, the relay operation gets initiated automatically to trip the whole load.
g. The server consists of two operating modes, namely
   - Auto mode.
   - Manual mode.
h. In Auto mode, a warning will be sent to the user either through SMS or a mail when the current or voltage exceeds the preset value.
i. In Manual mode, Button 1 will be used to trip a set of load manually inorder to protect the trans former.

IV. PROGRAM

The following set of programs is executed using a Tmega328 to get the expected result.

1. Initialization



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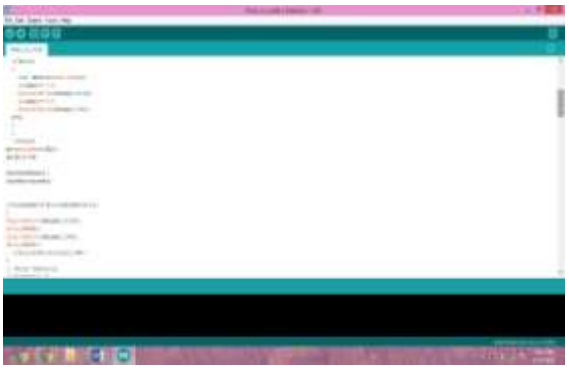
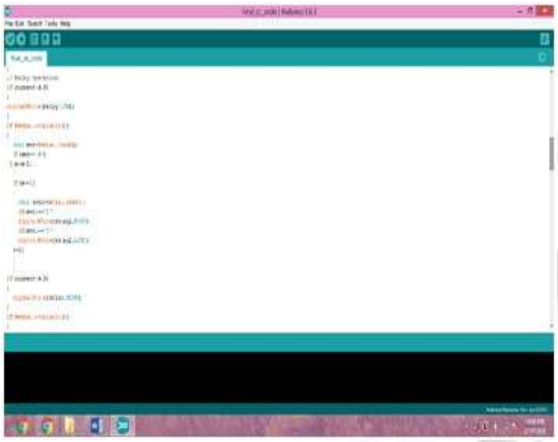
2 .Buzzer operation



3. Relay Operation



4. Current sensor

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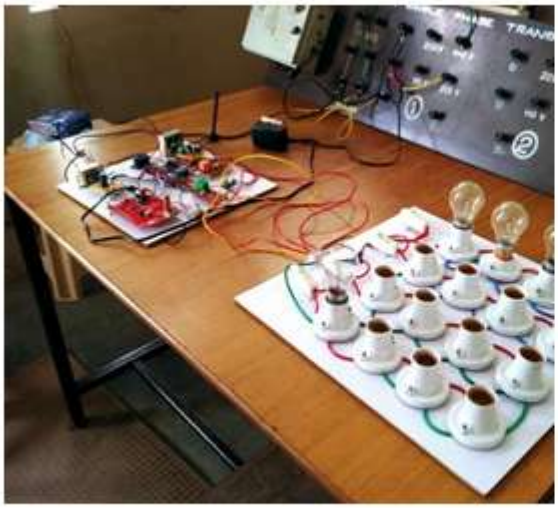
V. OVER ALL CONNECTIONS

The overall connection includes the complete project layout. The monitoring and controlling units, load and transformer are connected as per the project layout *(Fig.10)*



Date	Vol	Cnt
February 12, 2018, 6:02 pm	0	-0.00
February 12, 2018, 6:03 pm	0	-0.00
February 12, 2018, 6:03 pm	0	-0.82
February 12, 2018, 6:01 pm	109	-0.00
February 12, 2018, 5:45 pm	250	-3.64
February 12, 2018, 5:46 pm	250	-3.63
February 12, 2018, 5:47 pm	250	-3.64
February 12, 2018, 5:47 pm	250	-3.64
February 12, 2018, 5:48	250	-3.64

Fig.10: Overall Connection

VI. EXPECTED RESULT

1. Uninterrupted voltage supply results in normal operation of the transformer.
2. For accessing the www.iotcloudservers.com server, the user must have a specific username and password.

3. The current and voltage values should be measured by the corresponding current sensor and voltage measuring device and these values should be updated in the server.

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4. On switching the load, if the current reaches the rated current value, the buzzer becomes operational and if current exceeds the rated current value, the Relay should be operated automatically to trip the whole load from the transformer.

5. Auto mode

6. Manual mode

VII. FUTURE EXPANS ION

Since this project deals with a real time 1KVAtrans former connected to a resistive load, it can be expanded further for Indus trial purposes i.e., this idea can be implemented with necessary changes required for the industrial purpose. The load variation may occur depending on the end user but the concept of monitoring and controlling remains the same for every implementation with necessary advancement.

VIII. ADVANTAGES

1. High accuracy in monitoring.
2. Reduces human effort.
3. Prevent damages.
4. Domestic and industrial applications.
5. They can be accessed from remote area.

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