

Intelligent System Design for Early Warning and Cooling From Very High Temperatures in Voltage 30 Kv Transformers

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Abstract— The East Asian and North African countries, especially the Libyan state, rely on 30kv oil-cooled medium voltage transformers that require constant monitoring by engineers especially in the summer because of high temperature, affects the ability of transformers. The temperature of these transformers are sensed by the mechanical sensor (Albokhalz) which famous for its failures due to several factors impede its movement. therefore, necessitated the presence of human supervision, and if the supervisor is not in the station " whose is doing the manual separation" during the occurrence the emergency situation of the mechanical sensor, the heat Will cause the damage of this transformer, which will lead to the interruption of feeding on lines that feeding from it including vital lines which can be affected by power outages such as (intensive care rooms in hospitals, educational institutions and other vital institutions). In this paper, Intelligent System for Early Warning and Cooling from Very High Temperatures in Voltage 30 Kv transformers is designed. This design keeps the transformers from the unwanted rise in temperature. Also, another solution exists in this design if the temperature has risen to the level of danger. Here, the system will turn off the transformer to save it from the explosion and then, the all lines loaded on the transformer will be separated including vital lines. Then, the signal is sent to AVR device for putting it on automatic mode to raise the capacity of the second transformer. at the same time, two signals are sent, the first signal is sent to the "Fractionator" connection line which makes the vital line ready to connect to the second transformer, and second signal is sent to the conduction circuit device Siemens as to connect the vital line (Previously separated) with the second transformer located inside the station.

Keywords— transformer; buchholz relay; GSM SIM800; Microcontroller;

I. INTRODUCTION

Transformers are considered the devices that helped people meet their energy needs. A transformer is a static device consisting of a winding, or two or more coupled windings, with or without a magnetic core [1], for inducing mutual coupling between circuits; Transformers are exclusively used in electric power systems to transfer power between circuits with electromagnetic induction [2]. Power transformers used at each of the points where is a transition between voltage levels

and for step-down operation, mainly used to feed distribution circuits the construction of a transformer depends upon the application. For instance, transformers intended for indoor use are primarily of the dry type but can also be liquid immersed for outdoor usage [3]. Most countries especially North African countries including Libya depends on the oil-cooled transformers especially the 30 kV transformers for their high efficiency to reach the highest conversion rate designed for it, where increasing the cooling rate of a transformer from increases its capacity. Cooling methods must not only maintain a sufficiently low average temperature but must prevent an excessive temperature rise in any portion of the transformer (i.e., it must prevent hot spots). For this reason, working parts of large transformers usually submerged in high-grade insulating oil [4]. However, transformers oil-cooled need constant monitoring is divided into self-monitoring which is a protective device designed to deal with the events of emergency on the transformers and be installed inside the operating room of the transformer. It can be divided into special protection devices transformers into two types, first Prevention mounted on body transformer. The second is the protection on the transformer circuit that deals with the problems of the transformer with the electrical network, Gas Relay, Oil Level Gauges, Lightning Arrestors, Protective Relay, Differential Protection, Over Current Protection, Bochholtz Relay and a Buchholz relay [5]. It is commonly known as the gas accumulation relay is constructed so that it accumulates all or a fixed portion of the gas released by the protected equipment. It operates when the volume of gas reaches a certain level [6]. In addition, human monitoring of manual handling of emergency events on transformers, which determines the type of control is the key next to the converter be either automatic or manual, where Libyan state has adopted a control management to manual monitoring oil-cooled transformers called operating management and monitoring. Its mission is to employ engineers who supervise the operation of transformers in alternating groups throughout the 24-hour to Follow-up the distribution of the required load efforts as well as the control of transformers from an emergency occurs to it as coolant Low oil level in the transformer tank. It increase load signals, and converter oil pressure signal Using Buchholz

that consists of 2 Relays. The first to determine the level of transformer oil, and the second to sense the pressure of gases inside the transformer body pressed as the oil temperature rises send the sensor A signal that the heat of the transformer has risen to a protective or monitoring device for self- separating transformer. This increase in temperature usually caused by increased load, precisely at peak times during hotter or cooler weather, and human monitoring of manual handling of emergency events on transformers , which determines the type of control is the key next to the converter either be automatic or manual , especially During summer season, many power transformers are exposed to intensive, direct insolation. On the other hand, in recent years, the use of increasing number of air conditioning systems during summer caused growing trend of electrical load. As the consequence, blackouts of power transformers occurred during summer [7] often the gas pressure sensor often consumed mechanically because it contains mechanical movement. Consumption by reasons of loss of oil properties which prevents the movement of the mechanical sensor, and becomes compressed gas inside the adapter is unable to move the sensor mechanical to feel that the protection device that the temperature has risen. Then the monitoring will not disconnect the converter and then will cause serious damage if the engineer cannot turn off the converter because of his increasing voice, which indicates the increase of load [8]. If the engineer outside the power station severe damage to the transformer will cause damage and fire, and out of all the lines loaded on this converter, including vital lines for ex "such as sudden separation of electricity to the hospital care room " This is the most common problems which can be solved by solving the problem in installing the intelligent cooling system on the body of the transformer when reading the temperature in an instant manner by a sensor installed inside the poles off. The paper is structured in the following manner: in the section 2, system description is discussed. The installation and operation of the system is explained in section III. In section IV, the Simulation results is presented. Section V contains the conclusion.

II. SYSTEM DESCRIPTION

The cooling problem in the transformers mentioned previously are common especially in 30 kv transformer in Libya. To prevent fires, increase periodic maintenance and preventing the development of calcifications in these types of transformers, a smart cooling system is designed in this paper. This system separates between control of transformer oil and temperature control heat the transformer electrodes and it is composed of 10 components.

1. Microcontroller (arduino)

This electronic circuit provides ports for connecting electronic components, The Arduino circuit also contains a 16-megahertz (Crystal Oscillator) with a USB port for connection to the computer, and a separate power input. Also, it contains a small atmega 328 chip [9], which is used in controlled programming by atmel. This electronic circuit is shown in Fig. 1.



Fig. 1 A microcontroller

2. liquid crystal screen

In our work, this screen was used to display letters and numbers which is a 2x 16 screen [10] as shown in next figure.

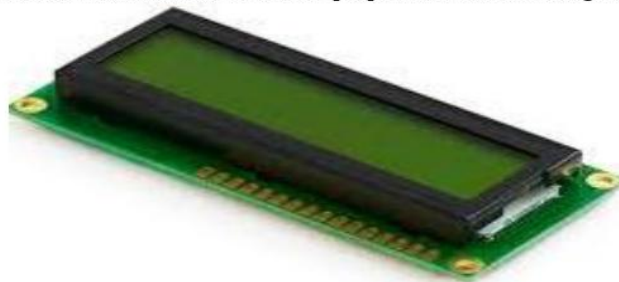


Fig 2. Display

3. Sensors DS18B20

The way this sensor works is that when we give it in its 5 volts, the output exceeds 1 mV [11], per Celsius degree i.e. that at 1 ° C the output will be 1 mV. This sensor can read the temperature between 50 to 150 ° C [12]. Fig. 3 shows this type.



Fig. 3 DS18B20 sensor

4. Resistor's

Fig.4 shows the resistors which their values among (560 ohms 10 K. ohms). These resistors are considered as the protection of micro-controller and they are placed on the entrances and exits of controlling.

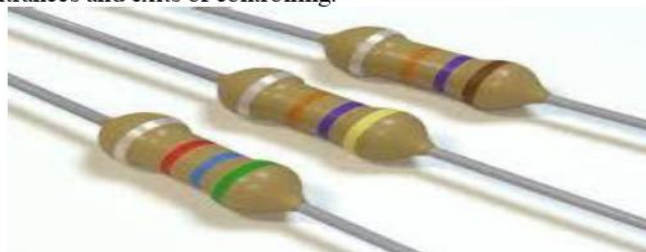


Fig5. Resistors

5. Relays

Fig. 5 shows the relay which works to relay a voltage and a small current to carry a large load and it advantages to lies in

its ability to completely isolation between the source and load circuit.



Fig. 5 Relay

6. Light diodes

Some photovoltaic diodes are shown in Fig. 6.



Fig. 6 Light diodes (lamp)

7. Bipolar Digital Integrated Circuit ULN2803

Fig. 7 shows bipolar digital integrated circuit ULN2803. This integrated circuit operates when receiving signal from the Arduino connections [13].

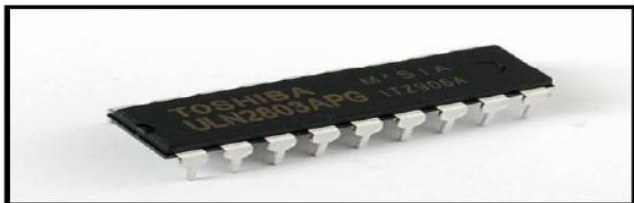


Fig. 7 ULN2803 piece full of transistors

8. Buzzer

Buzzer is shown in fig. 8.



Fig. 8 Siren

9. Fan

The type of the fan that using in our work is shown in the following figure.



Fig. 9 Fan

10. GSM SIM800

GSM SIM800 is in Fig. 10, and this device send a message sent by the controller.



Fig. 10 GSM SIM800

III. INSTALLATION AND OPERATION OF THE SYSTEM

First, the heat sensor is installed inside the transformer and the input of the transformer is installed and the fan is installed on the transformer oil cooling panels, outside the operating station. Then, the LCD display, red and green alarms and the alarm are all installed inside the operating station. Next, the signal cables are connected to the AVR to increase the capacity of the second transformer inside the station as well as the signal cable to connect the operating circuit to the vital line to load it on the second transformer after separating it from the first transformer. Finally, all the components will be connected to the control panel. The final form of this circuit is shown in Fig. 11. This system was programmed to include reference numbers for temperature. L was sent to the system by temperature sensor and was compared with reference numbers that were divided into four stages from 0 to 100 ° C, where these stages are less than 40 ° C of the hot spots that cause the transformers to collapse, which Will be at 140 ° C.



Fig. 11 Final assembly of a circle

When temperature inside the transformer is high, the sensor sends the temperature to the microcontroller, which compares it with the reference stages (Normal heat mode, High temperature, Very high temperature, Full closure for transformer for service) and this temperature is displayed on the screen LCD. On the basis of comparison results, the microcontroller selects function of the system, either by sending a signal to activate the fan on level the first or second, or Sends the signal to turn the lamp red or green, or Sends the signal to activate the siren to inform the supervising engineer that the transformer is at a critical stage, or Sends the signal to disconnect the transformer from service. Then, sends a message to a phone of the supervisor engineer of the operating station as a text message (the transformer temperature is very high and the transformer will be disconnected now from the service) to inform him about the situation of the transformer if the supervisor engineer outside the operating station. Thereafter, the system sends a signal to putting AVR device on automatic mode to raise capacity the second transformer that located at the same station. Then, the system sending two signals at the same time, first signal is sent to the "Fractionator" connection line which makes the vital line ready to connect to the second transformer that located on the same station, and the second signal is sent to connect the circuit device Siemens to the cutter of the vital line to be officially linked with the second transformer that located inside the station. The connection between the system and the transformer body is shown in Fig. 12 and Fig. 13 is an illustrative scheme of the system's entrances and exits and finally, this system is considered as early warning and cooling system.

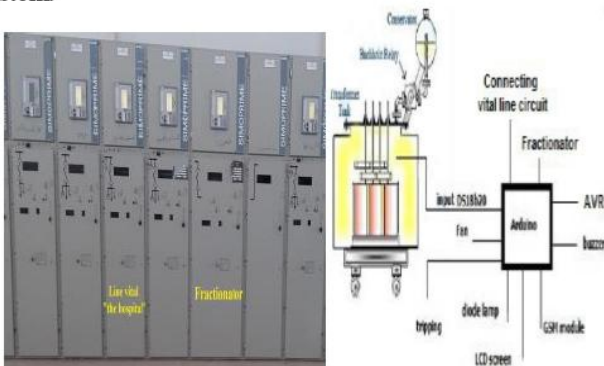


Fig. 12 the connection between the system and the transformer.

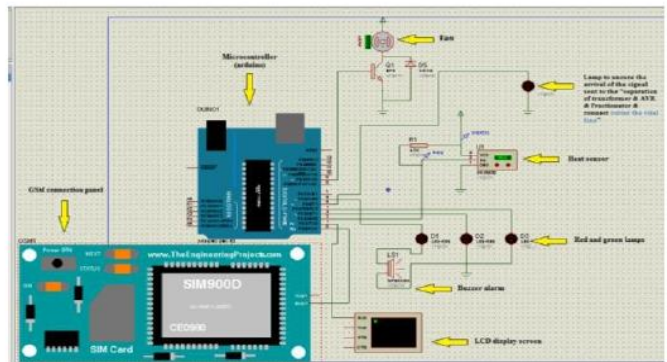


Fig. 13 illustrative scheme of the system's entrances and exits

IV. SIMULATION RESULTS

This intelligent system will be validate using the Proteus program, and all the pieces mentioned above will be selected. The most important component is the Arduino Plate and Fig. 14 shows the connection of all the components with each other.

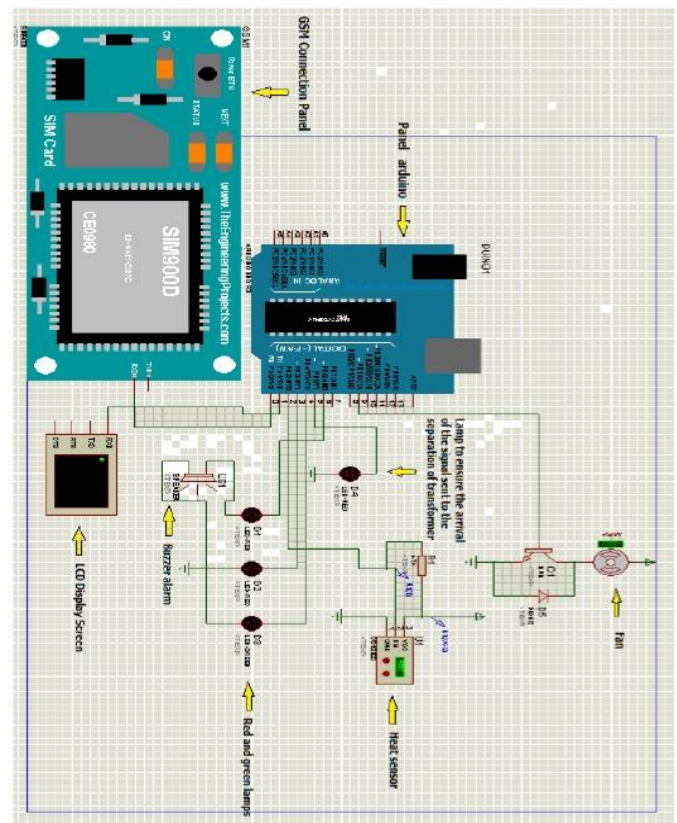


Fig. 14 the Circuit Components Connection

First, the program is run and heat sensor readings is changed. On the basis of comparisons, a microcontroller defines the type of outputs (Display, green light, red light, alarm clock, signal wire connected to the separation circuit of a transformer and fan). The heat sensor measurement is

considered as the input and it is displayed on the display screen and there are four comparison stages:

1. Normal stage: here, the temperature degree will be between (0-70) °C. In this stage, the microcontroller function is to run green lighting with momentary display on-screen of the temperature degrees that coming from the sensor. This stage is shown in fig. 15.

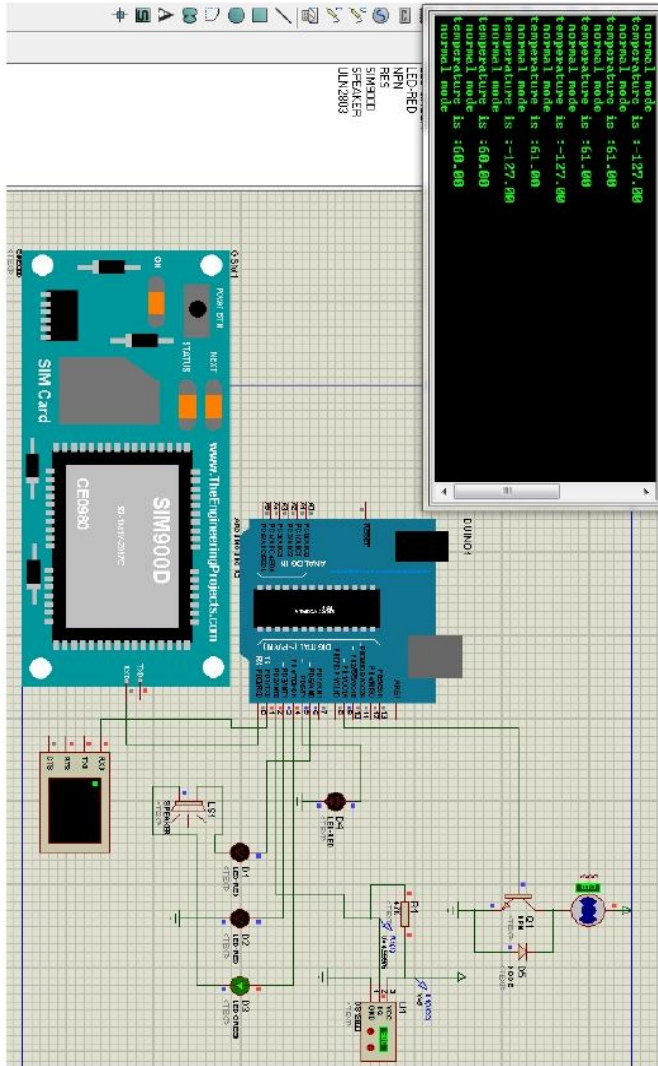


Fig.16 Normal Stage Mode

2. High temperature stage: In this part, a temperature will be between (70-80) °C. In this stage, the microcontroller function is to turn off the green light and replace it with red light as well as running the fan on the first level with an instantaneous display of temperature on the screen. The representation this stage is shown in Fig. 16.

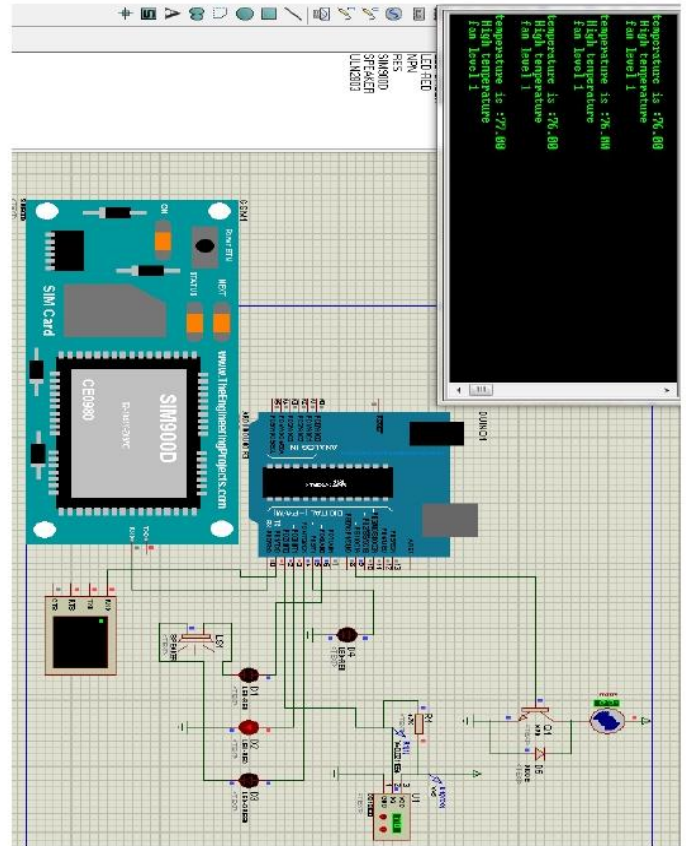


Fig. 16 High Temperature Stage

3. Very high temperature stage: In this part, a temperature will be between (80-90) °C. In this stage, the microcontroller function is to continue the red lighting as well as running the alarm clock. Also, the fan will be run on the second level. Fig. 17 shows this stage.

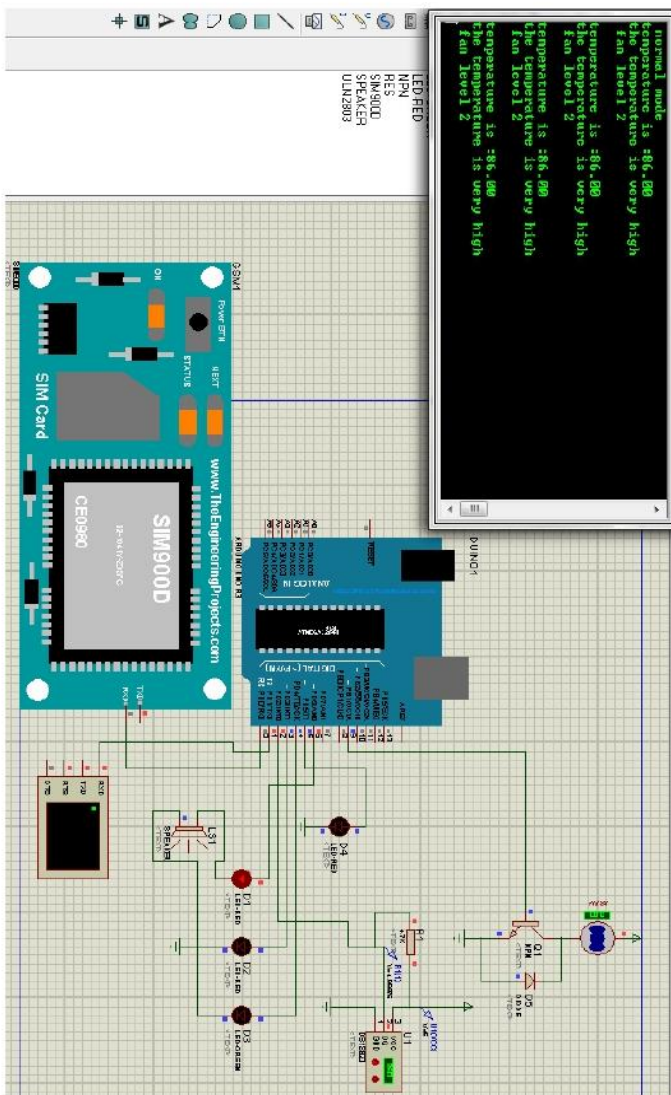


Fig. 17 Very High Temperature Stage

4. Full closure for transformer for service: Here, a temperature will be between (90, 100) °C. In this stage, the microcontroller function is continue to turn on the red light as well as the alarm clock and the fan on the second level until the temperature reaches 95 °C. Thereupon microcontroller will send a signal pulse to the line which will be linked to the separation circuit of a transformer (Off-duty). Also, the microcontroller works on extinguish the fan and the alarm will work continuously. Finally, a message will be sent by GSM. Then, the system will send a signal for putting AVR device on automatic mode to raise the capacity of the second transformer that located at the same station. Also, the system sends two signals at the same time, the system sends the first signal to the "Fractionator" connection line which makes the vital line ready to connect to the second transformer that located on the same station, and the system sends the second signal to the conduction circuit device Siemens. So as to connect the vital

line (Previously separated) with the second transformer located inside the station. This stage is shown in fig. 18.

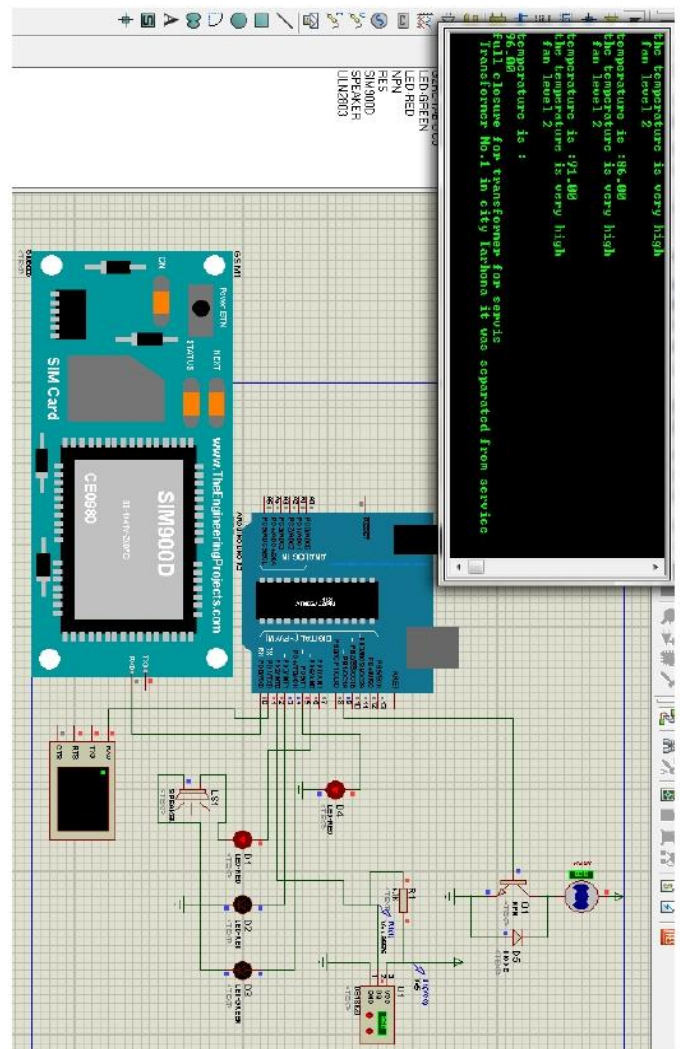


Fig. 20 Full closure of transformer

V. CONCLUSIONS

The large error rate in the mechanic sensor Balbakhluz caused a combustion of several transformers in power grid, which commissioned the General Electricity Company in Libya huge amounts of money. In this paper, Intelligent System for Early Warning and Cooling from Very High Temperatures in Voltage 30 Kv transformers has been designed. Depending on this design, the transformers were kept from the unwanted rise in temperature and if the temperature is not controlled by this cooling system and the temperature has risen to the level of danger, the system will turn off the transformer to save it from the explosion. Then, all lines loaded on the transformer will be separated including vital lines that cannot withstand the interruption of electricity "hospitals, educational institutions and other vital institutions. Then, this system sends a signal for putting AVR device on

automatic mode to raise the capacity of the second transformer that located at the same station. Also, the system sends two signals at the same time, the system sends the first signal to the "Fractionator" connection line which makes the vital line ready to connect to the second transformer that located at the same station, and the system sends the second signal to the conduction circuit device Siemens so as to connect the vital line (Previously separated) with the second transformer located inside the station.

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