Fault Clearance Ultra Sensing Electronic Circuit Breaker

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Abstract. As Electrical equipments are more sensible, it has to protect them from high current, short circuit occurrence. For tripping, fuse, relays and circuit breakers are employed to safeguard the power system components and circuits as well. Due to existence of sensitive components, much attention is taken to care about the protecting system. This paper explains the protection of equipments using suitable circuit breaker. Ultra fast acting electronic circuit breaker (UFECB) is designed to act as an over current protection device. Circuit breakers like fuse or miniature breakers are preferred for breaking the circuit once short circuit is occurred. In case, when overload fault occurs, the time of tripping is slow and which depends on percentage of overload. For instant fault clearance, tripping mechanism is activated for sensitive loads[1]. Time taken for the tripping mechanism is also considered in a great manner for breaking and making the circuit at short instant.

1. Introduction
Overload condition is the main cause of Electrical system failure. Transformer is designed to operate if the current flowing through an instrument is more than the rated value then the system may burn out due to overload. Current transformer is used to sense the load current and the output is fed to the ADC to digital data output. When the current increases beyond the excess limit, the load gets tripped by the relaying unit.

For the experimental analysis, NODEMCU ESP8266 micro controller is the vital part. The current will be sensed continuously via optocoupler. When any fault occurs, it sends signal to relay and relay cut off the current flow.

2. System Components

Node MCU ESP8266 is an advanced microcontroller which contains wifi module inbuilt in it. It contains 40 pins (input and output pins, source voltage pin, ground pin, serial data pin, 3.3v pin, etc). It consists of 2.4GHz antenna to receive signal for wifi module. Data transfer will be fast between the transmitter and receiver. This module can accept three types for interfaces (SP, UART, I2C). But SP interface will provide more data during processing.

ESP8266 is a Wi-fi module used in IoT kind applications and the module voltage is around 3V. This module can be used with arduino development board comes with built-in Wifi feature. As ESP8266 CANNOT BEAR more than 3.5V, care must be taken to safeguard the circuit settings. Storage speed, processing speed, sensors integration are notable advantages. To make compatible with other boards, shifting voltage level is made as this board doesn’t come with voltageregulator. This microcontroller is widely used in IoT based applications as it is cost effective. The key components of the proposed work are as follows.

1. MCU ESP8266
2. GSM Module
3. Relay
4. Optocoupler
5. Crystal oscillator
6. Voltage regulator
7. Liquid crystal display

**Relay**: Switching device used to ON/OFF. It consists of output pins (NC/NO pin), input pins and main (load) pin.

**Optocoupler**: It is a 6 pin device, send signal to the transistor after sensing. LED glows once input signal is detected.

**Crystal oscillator**: It is a pulse width modulator, produced due to vibration. It can produce signal up to 20MHz for NODE MCU ESP8266 module.

**Voltage regulator**: It is a 3 pin device used for obtaining output voltage.

**Liquid Crystal Display**: Acts as a display unit.

### 3. Block Diagram of the Proposed System

The working of smart UFECB can be explained using block diagram. The block diagram consists of three major units connected to the microcontroller comprises of battery-supply units, protection circuits, and display units. The current transformer (CT) senses and step down the current to a smaller value. Using optocoupler, voltage drop across the resistive element is measured from the main circuit. CT is preferred for this purpose as it provides isolation and avoids energy loss as well. 5v is to be regulated using microcontroller, which compares with the pre-set value that was already programmed in it. Supply is interrupted and tripped as the current goes beyond the preset value. Fault identification signal is send through GSM module to alert the user to reset the breaker settings to isolate the fault immediately.

![Block Diagram of Proposed Work](image)

**Figure 1**: Block diagram of proposed work

### 4. Experimental Setup

Testing is done under different loading conditions. Under the variation of load, overloading is detected and the relay tends to trip. LCD showed the overload status to the user through SMS and later supply has been cutoff. Supply is restored back after clearing the fault. With switching action, a short circuit condition was simulated and seems to be tripping time of around 0.002 seconds. UFECB is far superior in this regard as the operation time varies on the type of faults. Different loading conditions
were tested with the proposed system and the online monitoring can be implemented with the help of the GSM module with the network connectivity.

![Circuit diagram of the proposed project](image1.png)

**Figure 2:** Circuit diagram of the proposed project

![Experimental setup](image2.png)

**Figure 3:** Experimental setup

A coordination analysis is made to achieve optimum protective system by determining the settings of ampere ratings and over current settings. Protective device nearest to the fault will open when an over current occurs.
Operating characteristics of the breaker can be graphically represented on time-current characteristics. Tripping characteristics of the circuit breaker can be represented by a tripping curve which plots tripping time and current level. The curve represents the time required for a breaker to trip at a given excess current level.

| Voltage across CT (in Volts) | Filtered DC trip in Amp | Full wave AC and DC trip current in Amps |
|-----------------------------|-------------------------|----------------------------------------|
| 2.1                         | 13.24                   | 10.23                                  |
| 2.05                        | 12.16                   | 9.47                                   |
| 2.01                        | 11.23                   | 8.32                                   |
5. Conclusion and Future works

The proposed methodology protects the sensible equipments when fault occurs by cutting the supply in fraction of seconds. It is done by means of wifi technology. The instant of fault occurrence and the load current value can be predicted with the different loading conditions. Proposed methodology might have few issues with regard to current sensing, as current transformer reaches its settled value. In future, to avoid this situation, suitable current transformer is selected to avoid malfunctioning of protecting devices.

6. References

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