Automated Monitoring Test Rig for Circuit Breaker Operation

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***Abstract*—** The automated circuit breakers monitoring system described in this paper which is used for minimizing switching transient on power system to make or break current flow through the power system. The working of circuit breaker changes switching topology of a power system. The testing device can be connected to the breaker control circuit. It makes possible to track circuit breaker switching sequence and make conclusion about performance and outcome. Reliable operation of circuit breaker is possible by on-load monitoring the circuit breaker. It is not possible to maintain the reliable operation by regular inspection and maintenance. An automated monitoring system consist of processing module. The module process the voltage and current signals recorded by the device. It makes possible to track circuit breaker switching sequence and make conclusion about their performance and outcomes. The data recorded in the substation has been used to test power system.

Keywords—Circuit Breaker, Monitoring, Parameter extraction, Signal processing, Switching time.

1. INTRODUCTION

Circuit breakers are electromechanical devices used in power system to make or break the power flow at generator, load location and substation. Circuit breaker are capable of breaking, carrying, making current under normal condition and also making, carrying for a specific time and breaking current under specified abnormal condition such as short circuit breaker may have a lifetime of over 40 year. The majority of the time breaker remain closed and simply act as electrical conductor, but in many times they do indeed their performance protective and switching functions. breaker are operated by power system protective relays, which detect fault on the power system and identifying the appropriate circuit breaker needed to be open in order to isolate the faults and enable the rest of the of the system to function normally.

When the fault occur on such as short circuit current in an electrical system it an usually becomes necessary to operate an interrupting device. Interruption of current in a system frequently takes place during the transient condition when high current are present. The interruption produces an additional transient that is super-impose upon the instantaneous condition of the system. Thus it is recognized that interruption devices must manage with transient in the current generated in the system and the voltage transient that have been initiated by the interrupting device itself. This may creates very harsh working condition for circuit breakers. It is important that the circuit breaker are in good condition to be able to interrupt currents and prevent damage on the power system.

Circuit breaker are made in changing size, from small devices that protect low current circuit or personalized switchgear design to protect high voltage circuit deliver an entire city. In addition, a circuit breaker may operate through a manual command from power system operation. Sometimes the circuit breaker may not close or open on command leading the fault to exist for longer duration leading the system goes into the abnormal state causes power losses.

Different monitoring system have been design to monitor the status of circuit breakers and predicts the optimal maintenance schedule based upon the following measurement: The phase voltage, phase current and switching time. Normally the major and minor failure of the circuit breaker in series are caused by control circuit failure. Some of the data acquisition system currently available for measuring the signal for on-load monitoring of circuit breaker performance.

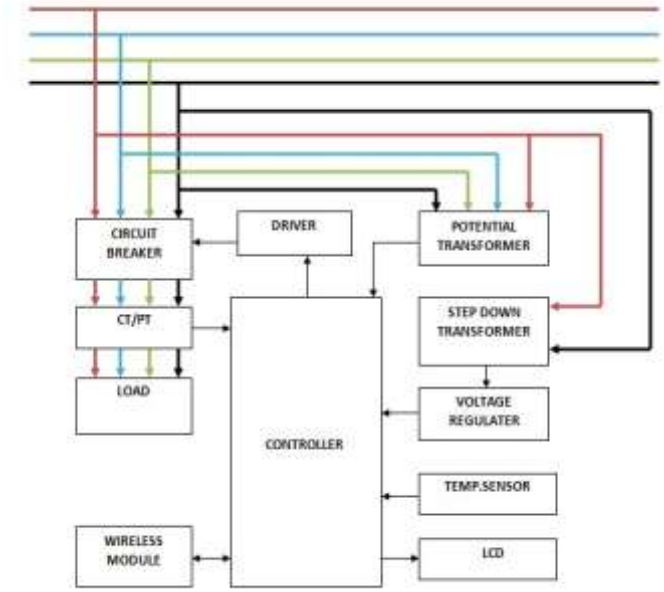
Most of the breaker failure that have been observed in field can be attributed to mechanical problem and difficulty related to control circuits. Normally near about 25% of the major and minor fault of breaker in service are caused by control circuit failure. Observing the control circuit failure, it is possible to make result about breaker health. Beside this control, circuit signal helps to make conclusion about the parts of breaker devices such as moving mechanism and mechanical contact.

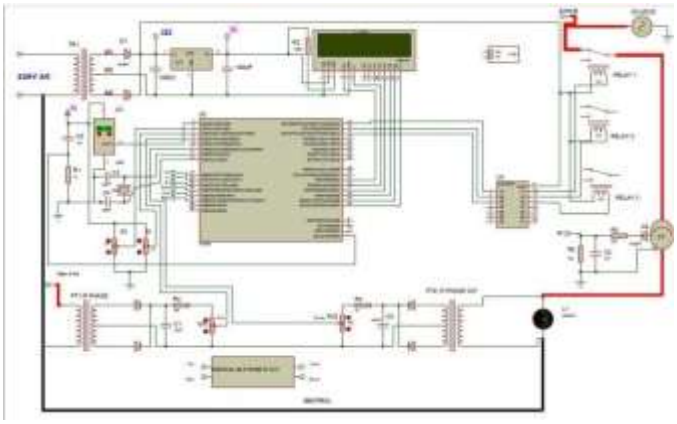
To improve the system operation, the data obtained by the on-load monitoring system should not be limited to evaluating the condition of the breaker. It is used to control the sequence of breaker operation and changes in topology of the system. It may be used to enhance the accuracy of control for constant operation. More reliable assessment of the system topology can be achieved by integrating redundant data from monitoring system. It may be also possible to adjust initiating the opening or closing operation to compensate for variation in the breaking or making times that are influence by the parameters being mentioned. Additional monitoring parameter may not directly reflect as an improvement in the system

operation but it may helps to increase the reliability of power system and equipment.

Data collected from breakers in the substation, the system should be combine to make deduction about topology of the system and operation that could help in increasing the system reliability. Such application required that given data should be synchronized in time.

2. HARDWARE





The circuit breaker monitoring system is design to perform following function

- Data acquisition system having input and signal must be captured and converted in to digital form when circuit breaker monitoring triggered.
- The data gathered by circuit breaker monitoring unit at breaker must be transferred to central location for further processing.

A. Microprocessor Module (16F886)

Microprocessor module performs the following functions:

- Detect event and record the data for specified duration in memory.
- Set the signal sampling frequency and the scaling factor for digital signal.
- Transmit the data to concentrator PC using communication protocol and wireless transceivers.

B. Temperature sensor :(LM35)

The temperature sensors measure the amount of heat energy generated by an object as well as the system, allowing as to detect or sense any physical change to that temperature producing either analogue or digital output. LM35 temperature sensor provides output voltage in centigrade (Celsius). It does not required any external calibration.

The LM35 low output impedance, linear output and precise inherent calibration make interfacing to read out or control circuitry especially easy. It can be with single power supply or with plus and minus supply as it draws only 60 micro- amp from it supply, it has very low self heating, less than 0.1 degree Celsius in still air.

C . Wireless Communication Module:

The concentrator PC gathers data from all slave unit through wireless communication. The wireless transmission system enables data transfer from multiple point to the central storage system. Bluetooth is one of the most wireless communication protocol in internet of things specifications, mainly advantages of this standard is its extremely a low power consumption, can helps making of full battery power boards with working time longer than one or two years in some of cases. The another features management protocol directly at kernel level without requesting any intervention by the user. Such type of facilities the set-up of a mess network of Bluetooth device with lower latency and higher range respective standard Bluetooth

D. Signal Conditioning Module:

The input signal must be scaled appropriately before converting them into digital form for processing and storage. By using rectifier converting the input signal in DC in the +5 volt a signal conditioning circuit must be scaled the signal to be in the range required by rectifier. This signal conditioning board protect rest of the device from high voltage transient generated during closed or trip coil operation.

E. Analog to Digital Converter

Analog signals must be converted to digital signals with a resolution high enough to allow an accurate analysis. A resolution of 12 bits to 16 bits sufficient for most of the application. Digital signal are easy and reliable for observation and future study. To make sure that recorded data may be combined with data from other circuit breakers monitors in a system all signal must be sampled synchronously and then converted to digital form.

3. CIRCUIT BREAKER MONITORING

Need for the proper maintenance of breakers is important, as the breaker may remain idle, either close or open for long times. They are also often located in remote areas, which makes their maintenance and inspection more difficult and expensive. For reliability of operation of the power system through various system analysis it is necessary to know system topology configuration. Remote and real time monitoring seems to be perfect solution for equipment conditioning and status monitoring

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Different monitoring system have been design to monitor the condition of different circuit breaker element, detect circuit breaker health and predict the time intervals for maintenance. All those devices monitor different physical values such as: the phase current, voltage, temperature, and opening or closing time. Some of the data acquisition system currently available to cater to measuring quantities from the control circuit are not suitable for on-load monitoring application of circuit breaker performance in a switching sequence that involve multiple circuit breakers because do not record enough information to make accurate observation and diagnosis of control circuit fault that may occur on multiple circuit breakers. Most of them do not have the sufficient number of channel, on-load monitoring and time synchronization capabilities to enable the artificial intelligence tools to make good decision about the status of the circuit breaker and or the system. Most of the existing monitoring system do not have any option for time synchronization of recorded data.

4. ANALYSIS OF SEQUENCE OF OPERATION

The purpose of power system is to generate and distribute electrical energy to customers, A power system consists of diverse equipment, which is expensive. In order to build reliable protection system it is important to sense or detect fault and disconnect vulnerable element of the power system fast.

Circuit breakers have the purpose to automatically connect or disconnect different parts of the power system in order to isolate fault. When there is a fault on an element in power system, it is necessary to open all circuit supplying fault current very fast. In order to disconnect all the circuit that supply fault current, more than one breaker typically react. Bus arrangement is used to reducing the number of circuit that must be opened in case of fault. Depending upon the bus arrangement of power system network and status of circuit breaker, different circuit breakers will automatically react in case of different fault.

Power system may have to be expanded to meet growing demand for electrical energy. In order to fulfill the increased demand new substation are built and old ones are upgraded. It is common that bus arrangement vary widely from substation to substation. In practice many different solution can be found, most of the common arrangement in high voltage system are breaker-and-a-half and ring bus arrangement. In the case of any fault on line3, corresponding circuit breakers from both ends of line3 the breaker1, breaker2 and breaker3 will open and de-energized the line to get rid off temporary fault. During action to disconnect an element, various circuit breakers will react differently depending upon the bus arrangement and type of fault such as permanent or temporary. Purpose of the proposed analysis should be finding out whether the sequence of event executed correctly according to bus arrangement and cause of the action.

5. ANALYSIS OF CIRCUIT BREAKER

The circuit breaker switching operation analysis is divided into the two section where one section is control the operating sequence and another section control the closing sequence.

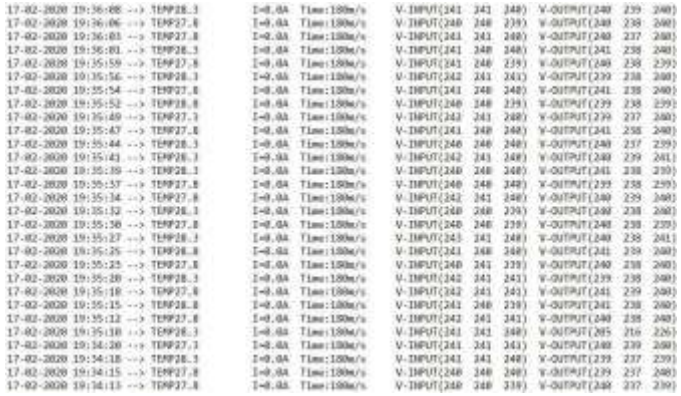
When the circuit breakers is in the close state, the operation begins with a trip initiate signal being with a trip initiate signal being send to control circuit from an operator. The closed contact allow the signal to travel along the line. The voltage and current being travel through the line. If the faulty may occur the voltage may increase or decrease suddenly and the circuit may trip up to that time the circuit breaker is in operating mode. When the circuit breaker is in the open state from that time up to which the supply towards the other side is on or the circuit breaker is in the closed state. From that operating state to closing state the time and data may recorded and being send to control circuit.

The availability of new data from circuit breaker brings possibilities for the new type of analysis. Detailed analysis of single circuit breaker behavior is of great importance for the maintenance groups. Other utility groups like protection engineer and maintenance engineer or more interested in sequence of event associated with group of circuit breaker. They are interested in knowing when the sequence started , what caused the operation and faulty whether the sequence executed correctly.

In order to meet the above requirement it was necessary to provide automatic retrieval of the digital data from a group of circuit breakers to the central respiratory: the given data helps to comparing control circuit signal from different circuit breaker on the same time scale. Circuit breaker monitoring architecture is design to upload the features like voltage, current, closing/opening time.

6. TOPOLOGY OF SEQUENCE OF EVENT ANALYSIS

On load monitoring circuit breakers data has more information available to estimate the circuit breaker status then what is available through existing tools. Since circuit breakers tracts the topology change with more details. Knowledge about current status of the system topology is important for power system application like fault location and alarm processor which demonstrates the importance of proposed architecture for future improvement of existing tools.



7. CONCLUSION

The on-load monitoring circuit breaker is described in paper and present requirement is that the system should satisfy to enable cost effective and efficient breaker monitoring function. It should be design for status monitoring purpose for the medium and high voltage breakers. By the following these requirement, it should be enable to realize low cost and efficient monitoring and provide the data that could be used to improve several power system analysis function. It gives generic system architecture that enable minimum cost realization of the system. Hardware architecture should be modular to enable effective upgrade, easy and obsolete part exchange in future.

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