Novel Design of Fault Breaker for Real-Time Application with Time Control Using Microcontroller 16F877A

Abdullah J. H. Al Gizi[1*]

[1]Southern Teknologi Universiti

Corresponding author: E-mail addresses: abdullh969@ yahoo.com

Abstract: - The paper presents the design, simulation, implementation and testing of the Fault breaker test device with time control based on a relay and microcontroller PIC. Fault breaker test is widely used in electrical machines and equipment's winding for measuring the rated current and calculation the constant losses and efficiency;   it consists of three relays , microcontroller PIC, LCD display ,three thermo resistance loads with a common power supply ;its Fault breaker test current is converted in the thermo resistance variation to thermal loses .There is no Standard Fault breaker current tester device but there are some techniques used thermal resistances variable the value of resistance depends on long - but has its drawbacks – relative no give accuracy result , hard to adjust with time control , relative not safety , not suitable to do the test with time control .The originality aspects of the work come from the unique method of do the transient fault with time control in high accuracy by setting the time of fault range starting 10 millisecond to 10 minutes and types of fault for any device in safety and clear the fault after time of fault finish immediately, and run the fault by push the switch ON .This method uses only peripherals from a microcontroller so is low cost and easy to adjust. This is due to their simple regulator, high reliability, low cost and fast reaction. The novel design very good to be used in real application.

Key-Words: - Fault Breaker Test, PIC, LCD , Transient Fault, Time Control

1 Introduction

Thus, an indispensable condition for satisfactory system performance is the synchronization of force systems. This characteristic of stability is critically guided by the force-angle relationships and the dynamics of generator rotor angles. Instabilities may also arise due events without losing the synchronism. A system containing a synchronous generator supplying an induction motor load during the transmission may become mentally ill because of the failure of load voltage. It is indeed customary to analyze the stabilities of power system subjected to transient events. These events might be weak or strong depending upon the event types[1]. The transient voltage stability[2, 3] in electric power systems is relatively a new domain of research and much of it are still unexplored. The voltage stability can be divided transient, midterm and lasting stability phenomena.

The midterm phenomena represent the transition from short-term to long-term responses. In mid-term stability studies the focus is on synchronizing power oscillation between machines including the effects of some of the slower phenomena and possibly large voltage or frequency excursions. Typical ranges of time periods are, (i) Short-term or transient: 0-10 seconds, (ii) midterm: 10 seconds-few minutes and (iii) Long-term: few minutes-10's of minutes. The transient stability is primarily concerned with the maintenance of synchronism for large disturbances which is our main focus. There are two types of disturbance in voltage stability, namely the small and large-disturbances. The large one worried with the system aptitude to control voltages following a huge disturbance such as system faults, loss of generation or circuit's contingencies. Conversely, the small-disturbance voltage stability deals with the system's ability to control voltages following small perturbations such as incremental changes in system load.

Many issues related to the voltage stabilities under disturbances are far from being understood due to lack of comprehensive models and careful simulation. Researches concerning the improvement of the search process to control system engineering problems proposed different approaches to get better solutions, while the AVR system optimal control is performed by the PID inside the AVR. To analyze the performance of the AVR system under severe disturbance or any types of disturbance with time control short–term (transient), midterm and long-term is applied at the generator terminal. So that we design and manufacture the device for Fault breaker test with time control range starting 10 msec to 10 minutes for any device in safety, such as: generator, transformer..etc., The maximum of Fault breaker current is 30A.The systems combine fine electronics circuit, microcontroller PIC and visual C program to achieve better performance with lower cost and time control when compared with traditional Fault breaker test approaches. This device used to analyze the performance of the generator or transformer...etc., by apply any types of fault such as single phase, two phase, three phase..etc. and shows the system response for above contingency.

2   Problem statement

To analyse the performance of the AVR system under severe disturbance or any types of disturbance with time control short–term (transient), midterm and lasting is applied at the generator terminal.

3 Problem Formulation

3.1   SIMULINK Modeling of Fault breaker device

Implement programmable line-to-line and line-to-ground fault breaker system

3.2   Description

The 3-Ø Fault block implements a three-phase circuit breaker as shown in Fig.1 where the opening and closing times can be controlled either from an external Simulink signal (external control mode), or from an internal control timer (internal control mode).
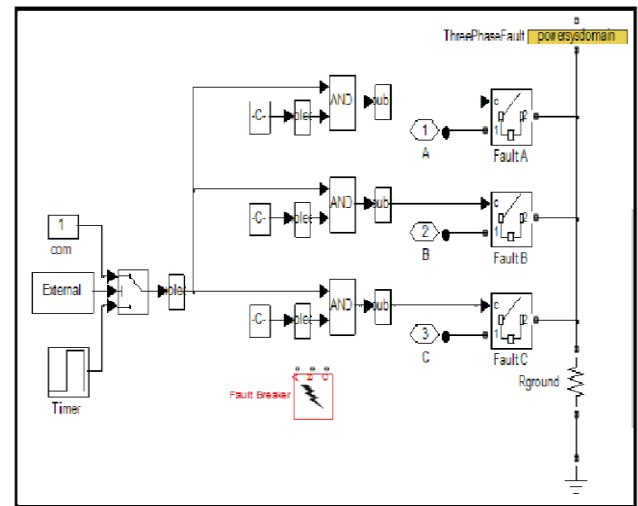

Fig.1 Fault breaker

The 3-Ø Fault block usages three Breaker blocks that can be separately switched ON-OFF to program Line-to- Line faults, Line-to-ground faults, or a mixture of Line-to- Line and ground faults.
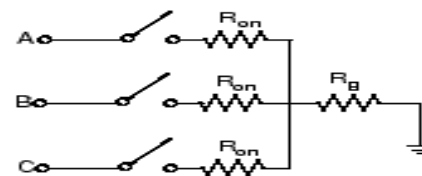

Fig.2

The ground resistance Rg is robotically set to 10^6 ohms when the ground fault choice is not automatic while Fig.2 shown the connection of ground resistance Rg with internal resistances Ron for lines A, B, C. E.g., to program a fault between the line A and B you need to select the line A fault and line B fault block limits only. To program a fault among the line A and the ground, you need to select the line A fault and ground fault limits and stipulate a minor value for the ground resistance. If the 3-Ø fault block is set in outside regulator mode, a regulated input looks in the block icon. The regulator indication linked to the fourth input obligation be either 0 or 1, 0 to open the breakers, 1 to close them. If the 3-Ø fault block is set in interior regulator mode, the switching periods and status are specified in the dialog box of the block .Series Rp-Cp snubber circuits are involved in the model. They can be optionally linked to the fault breakers. If the 3-Ø fault block is in sequence with an inductive circuit, an open circuit or a current source, you obligation use the snubbers.
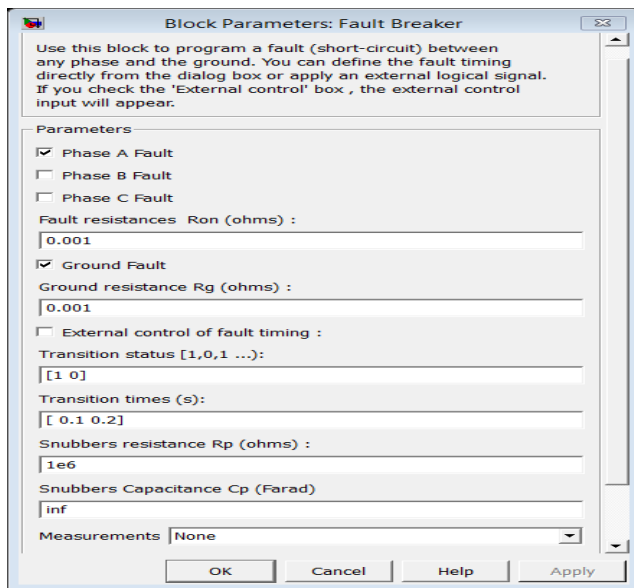
Fig.3 Dialog Box and Parameters

Depends on the Dialog Box and Parameters as shown in Fig.3 above we can set phase A ,B ,and C fault by nominated, the fault switching of line A is triggered. If not nominated, the breaker of line A stay in its initial status. The initial status of the line A breaker agrees to the accompaniment of the first value stated in the vector of change position. The original status of the fault breaker is typically 0 (open). Though, it is likely to twitch a simulation in a stable state with the fault originally practical on the system. E.g., if the initial value in the change status vector is 0, the line A breaker is originally closed. It opens at the first time stated in the change time(s) vector. If designated, the fault switching of line B is triggered. If not designated, the breaker of line B breaks in its original status. The original position of the line B breaker agrees to the accompaniment of the first value stated in the vector of change status. If designated, the fault switching of line C is triggered. If not designated, the breaker of line C stays in its earlier status. The early status of the line C breaker agrees to the accompaniment of the first value stated in the vector of change status.

3.3   Fault resistances Ron

The interior resistance, in ohms (Ω), of the line fault breakers. The fault resistances Ron limit cannot be set to 0.

3.4   Ground Fault

If designated, the fault switching to the ground is triggered. A fault in the ground can be programed for the triggered lines. E.g., if the line C Fault and ground fault limits are designated, a fault to the ground is applied to the line C. The ground resistance is set inside to $1e^{6}$ ohms when the ground fault limit is not designated.

3.5   Ground resistance Rg

The Rg (ohms) limit is not visible if the ground fault limit is not designated. Rg, in ohms (Ω). The Rg (ohms) parameter cannot be set to 0.

3.6   Transition status

Stipulate the vector of swapping status when using the 3-Ø breaker block in interior switch mode. The designated fault breakers open (0) or close (1) at each change time rendering to the change status limit values. The early status of the breakers agrees to the accompaniment of the first value stated in the vector of swapping status.

3.7   Transition times(s)

Stipulate the vector of swapping times when using the 3-Ø breaker block in interior switch mode. At each change time the designated fault breakers opens or closes contingent to the initial state. The Transition times (s) limit is not visible in the dialog box if the outside regulator of swapping times limit is designated.

3.8   Snubbers resistance Rp

The snubber resistances, in ohms (Ω). Regular the Snubbers resistance Rp limit to inf to eliminate the snubbers from the model.

3.9   Snubbers capacitance Cp

The snubber capacitances, in farads (F). Regular the Snubbers capacitance Cp limit to 0 to eliminate the snubbers, or to inf to become resistive snubbers.

3.10   Inputs and Outputs

The three fault breakers are linked in Wye among terminals A, B and C and the interior ground resistor.

If the 3-Ø fault block is regular to outside control mode, a Simulink input is additional to the block to regulate the opening and closing of the three interior breakers. The next section will be explained the novel manufacture, design, device that is very valuable to be functional in actual use.

4 Model of Fault breaker device to real-time application

The AVR is utilized for controlling the terminal voltage by regulating the exciter voltage of the generator, while the AVR system optimal control is performed by the PID inside the AVR. To analyse the performance of the AVR system under severe disturbance or any types of disturbance with time control short–term (transient), mid-term and long-term is applied at the generator terminal. So that we design and manufacture the device for Fault breaker test with time control range starting 10 msec to 10 minutes for any device in safety, such as: generator ,transformer ..etc., the maximum of Fault breaker current is 30A.The systems combine fine electronics circuit , microcontroller PIC and visual C program to achieve better performance with lower cost and time control when compared with traditional Fault breaker test approaches. This device used to analyses the performance of generator or transformer ...etc, by apply any types of fault such as single phase, two phase, three phase..etc and shows the system response for above contingency. This device is able to control by types of fault and the time of fault in the terminal voltage to test the control system ability to improve the transient response and damping characteristics. In such device for Fault breaker test attached on generator terminal voltage is a key element for control and, usually, it is a Fault breaker test device due to its ruggedness and ability to operate in harsh industrial environment. The Fault breaker test device consists of three relays , microcontroller PIC, LCD display ,three thermo resistance loads with a common power supply ; the setting of fault types and the time of fault done by four push button first one for on/off and the second for phase selection ,third time increase and four time decrease . This leads to setting the fault types and time of it dependence with relays work to change the elements open and close connection. To evaluate this dependence a simple stand for testing devices for Fault breaker measurement was developed (Fig.4) and different devices were tested. Fig.4 showed the traditional thermal resistance that used to connection with device to test the Fault breaker. Fig. 2 showed the novel device that used to Fault breaker test for any device. Traditional approach to do Fault breaker test depends on different technique such as used thermal resistance but without time control technique as shown in Fig.4.This technology works not bad but is hard to adjust time especially in transient, test by uses many components and offers

no connection to computer systems or fault time and fault type control.

Fig.4 Thermal resistance long 20 meters that used to connection with device to test the Fault breaker.
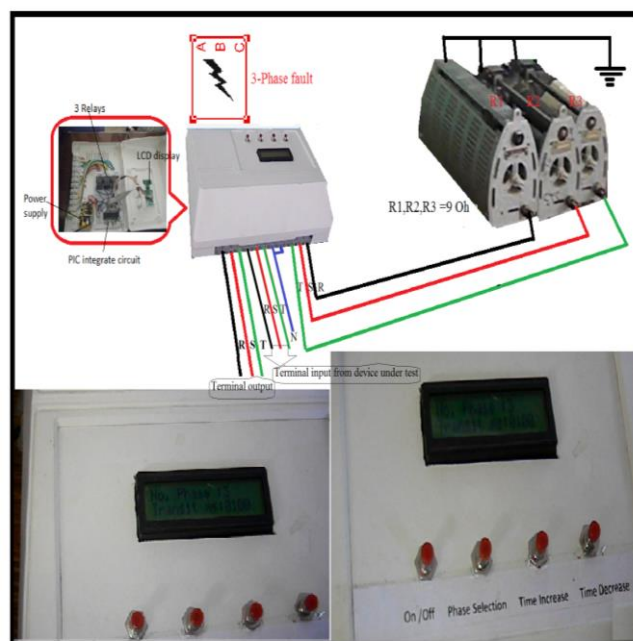

Fig. 5 Stand for testing measuring Fault breaker by using novel Fault breaker test device.

On the other hand the novel device technique is safety to test Fault breaker for generator, transformers or motor..etc and provide high ability control time and types of fault . Efforts were made to develop a method for Fault breaker test using combination of three relays , microcontroller PIC, LCD display ,three thermo resistance loads with a common power supply. The device for Fault breaker test with time control range method is based on the

setting of fault types and the time of fault by four push button as shown in Fig.5.

4.1 System description

The input from the stable power supply unit (230 V AC) is converted into 12v AC by means of a step down transformer, the output of this is used as input to bridge rectifier circuit. Here in this system bridge rectifier will generate 5 V DC with the help of regulator china 74073342 ULN2003 APJ. The output of the 7805 regulator is used as an input to the PIC. The PIC will generate pulses to drive the three relays according to the requirement. As the output voltage of the PIC is in mV, driver circuits are used to drive the three relays by open and reclosed relays elements according to timer setting time. The rating of the relays should be chosen according to the rating of the power circuit. Peripheral Interface Controller (PIC) is a term introduced by Microchip technology. PIC 16F877A is a family of CMOS 8-bit Flash microcontrollers[4]. Power consumption is very low. PIC16F877A is a 40/44-pin device which can operate at up to 20 MHz clock speed. It has 8K * 14 words flash program memory, 368*8 RAM data memory, 64bytes of EEPROM nonvolatile data memory, 8-bit timer with pre-scalar, watchdog timer, Only 35 single-word instructions to learn, external and internal interrupt sources and large sink and source capability. The architecture is shown in Fig.6[4].
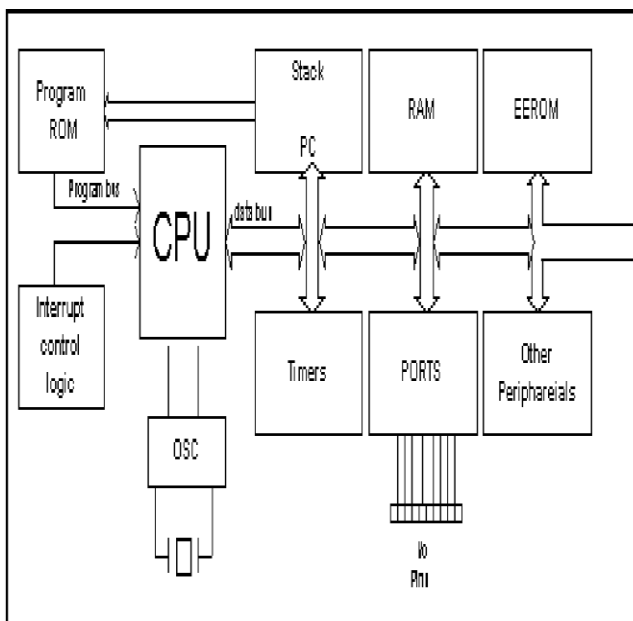
4.2 Implementation and Test Results

The measurement method was tested using a novel Fault breaker test device (Fig.10, right). A 16 bit microcontroller board was integrated into novel Fault breaker test device – the Fault breaker devices is able to control of fault types and the time of fault. The integrated electronics implements microcontroller PIC and visual C program to achieve better performance with lower cost and time control when system, as well as displacement measurement with novel Fault breaker test device[5, 6].Microcontroller was programmed in high level language that allows easy implementation of algorithms and communication procedures[5]. Using presented test bench was possible to evaluate the precision of measurement method. Microcontroller stores displacement as 16bit variable so maximal range is 0…65.535 and it's possible to have time control from 10 millisecond to 10 minutes. Results for a novel Fault breaker test device are shown in Fig. 8,9,10,11,12 ,13,14 and show good time severe disturbance control from 10msec to 60 mesc are collecting by used the experimental set up of the device for Fault breaker test with time control as shown in Fig 7 [7].
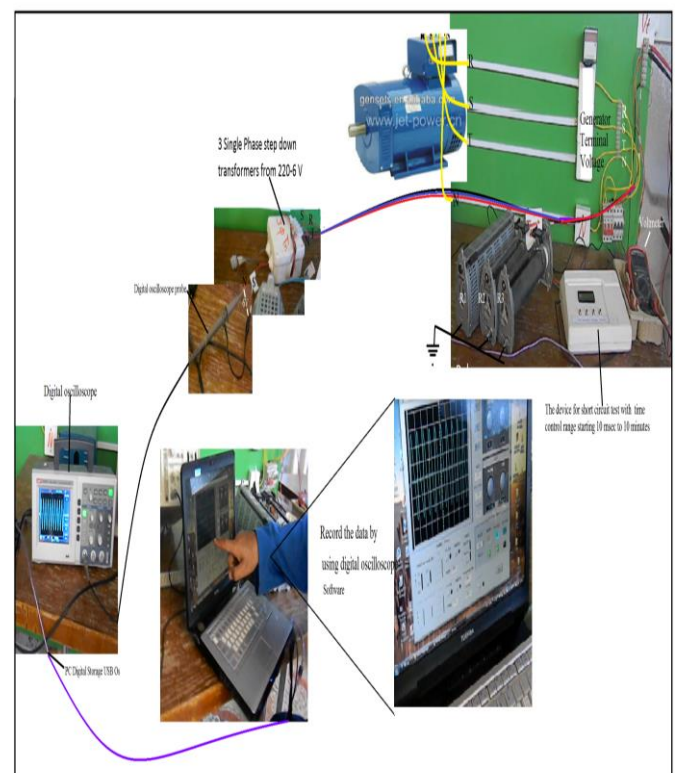

Fig.7 Shown the experimental set up of the device for Fault breaker test with time control.

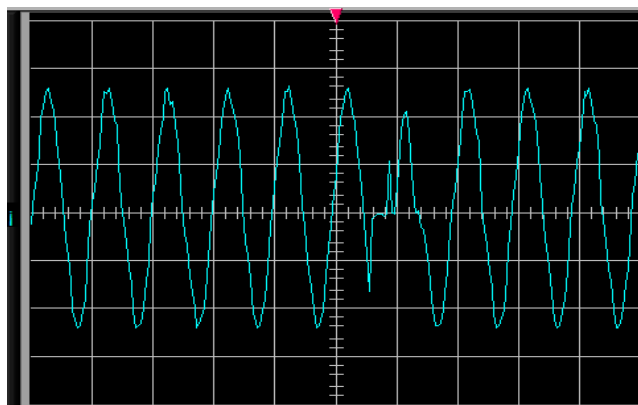**Fig.6** Architecture of PIC16F877A Microcontroller.

Fig.8 Influence of generator terminal voltage under severe disturbance time 10 msec on generator terminal voltage.
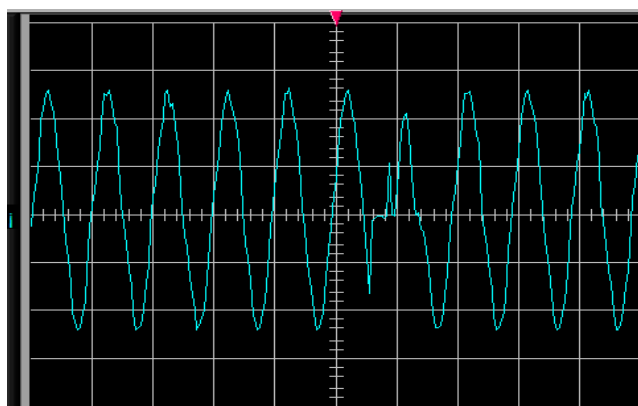

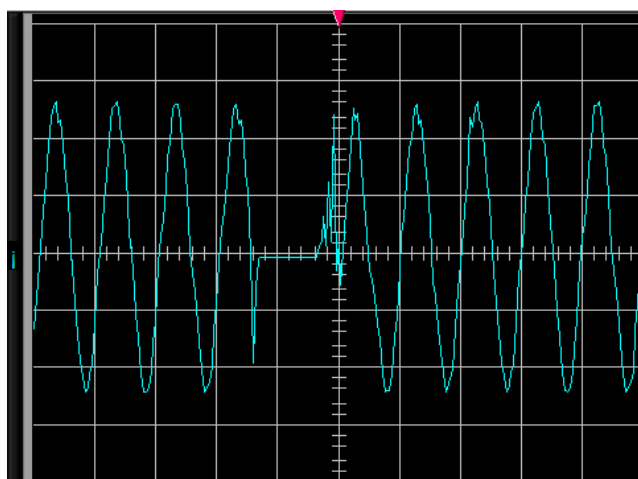Fig.9 Terminal Voltage under severe disturbance under fault time 10 msec.

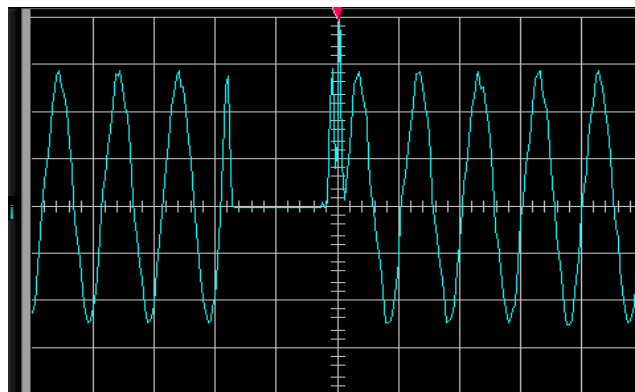Fig.10 Terminal Voltage under severe disturbance with under fault time 20 msec.

Fig.11 Terminal Voltage under severe disturbance under fault time 30 msec.
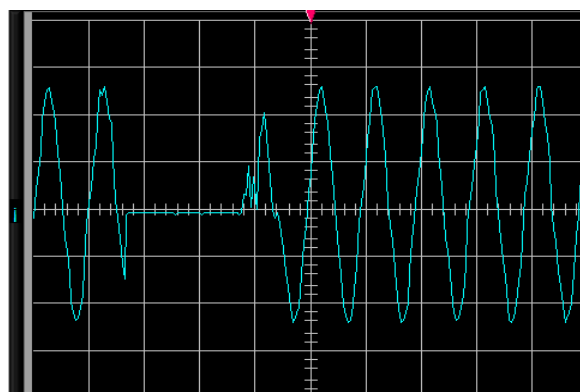

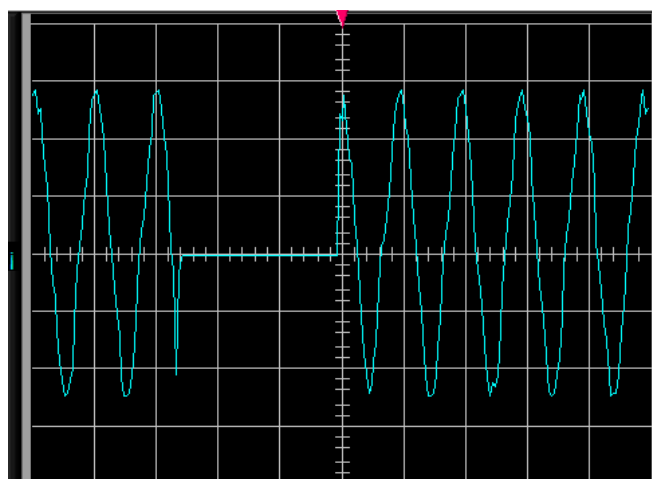Fig.12 Terminal Voltage under severe disturbance under fault time 40 msec.

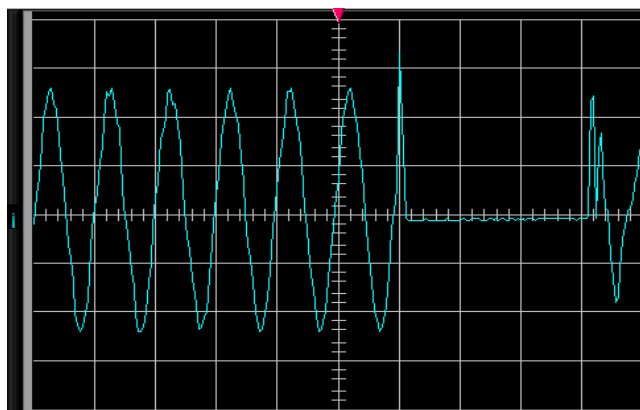Fig.13 Terminal Voltage under severe disturbance under fault time 50 msec.

Fig.14 Terminal Voltage under severe disturbance under fault time 60 msec.

Error curve for these results is under 1% for the entire range (Fig.15). Error occurs due to digitization noise and precision of measurement method but also from timer nonlinearity. There is an efficient way to experimental fault test for a specific time of fault. This method dramatically increase required precision time control of fault and the type of fault with safety for device under test is enough for a given application.
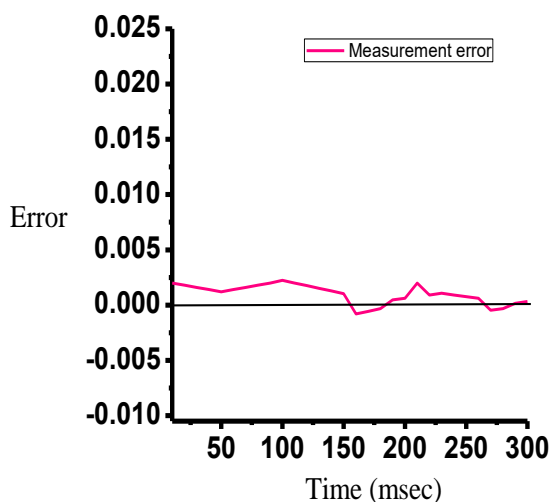

Fig.15 Measurement error curves a novel Fault breaker test device.

5 Conclusions

A novel Fault breaker test device is can be easily modelled and simulated using standard software tools. Modern 16 bit microcontrollers integrate all required peripherals required for industrial control and allow the implementation of time fault using timer programmable as well as and types fault. So that, a novel Fault breaker test device is well suited for fault type and time control applications for test the winding machines due to safety for measuring test and higher precision. The Microcontroller based adjustable closed-loop relays controller system has been developed the speed control of on/off relays circuit with timer. The results showed that the microcontroller is a reliable instrument to control the Fault breaker test device. This system is applicable to different sizes of machines test and capable of controlling the time of fault with very high precision.

References:

[1]   Kundur, P., *Power System Stability and Control*. . Vol. Example 12.6. 1994: McGraw-Hill.

[2]   Al Gizi, A.J. and M. Mustafa, *Hybrid Neural Genetic and fuzzy logic approach for real-time tuning of PID Controller in AVR System.* Life Science Journal, 2013. **10**(4).

[3]   Mustafa, M. and A.J. Al Gizi, *Hybrid Neural-Genetic and fuzzy logic approach for real-time tuning of PID Controller to improve the System frequency response of AVR System.* Life Science Journal, 2013. **10**(4).

[4]   Mazidi, M.A., *PIC Microcontroller and Embedded systems using Assembly and C for PIC16.* Pearson Education, 2008.

[5]   Drumea, A., P. Svasta, and M. Blejan. *Modelling and simulation of an inductive displacement sensor for mechatronic systems*. in *Electronics Technology (ISSE), 2010 33rd International Spring Seminar on*. 2010. IEEE.

[6]   Drumea, A., et al. *Modelling and simulation of simple mechatronic system-position control solution based on linear variable inductor displacement transducer*. in *Electronics System-Integration Technology Conference, 2008. ESTC 2008. 2nd*. 2008. IEEE.

[7]   Al Gizi, A.J., et al., *Integrated PLC-fuzzy PID Simulink implemented AVR system.* International Journal of Electrical Power & Energy Systems, 2015. **69**: p. 313-326.

Abdullah Jubair Halboos Al Gizi received his BSc. Eng Degree (1995), M. Sc. (2003) from University of Technology Baghdad, PhD from Universiti Teknologi Malaysia. He is currently lecturer at Iraqi Southern Technical University.

(E-mail: abdullh969@ yahoo.com).