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Design of Overcurrent Protection System Based on Arduino Mega

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ABSTRACT: The electric power protection system is one of the most important things in the electric power network. Because this affects the reliability of the electric power network and supply to customers. In the protection system, especially on the 20 kV distribution side, it is very common for OCR (Over Current Relay) and GFR (Ground Fault Relay) relay faults to occur.
This disturbance causes the PMT and recloser to work if the current has started to fall into the fault category. Reliability of PMT and recloser must be maintained for the protection of the transformer. Both the fault setting or the PMT and recloser settings controlled by the protection relay must be properly coordinated by the controller program.
This setting can be done by the Arduino Mega minimum system which will provide control of the PMT contactor and recloser contactor according to its working basis. This setting is designed as closely as possible to the characteristics of definite instant.

Keywords: protection, OCR, GFR, Arduino Mega, ACS712 ,Current Sensor

I. INTRODUCTION

An electric power protection system is needed to protect each of its components. The main function of the protection system is to secure the equipment as quickly as possible from disturbances that can interfere with and or damage the electrical power system equipment. The disturbance can be in the form of overvoltage or overcurrent. Overvoltage will cause damage to equipment insulators, such as transformer winding coatings, and conductors insulators. While the overcurrent will cause heat to arise in the conductor.

Arduino Mega is a microcontroller device in which commands (programs) can be entered to control an electrical circuit. The electrical circuit in question can be in the form of a simple electrical circuit, such as an LED circuit, to a fairly complex electrical circuit, for example an electrical circuit that requires a sensor as a sensor.

By utilizing the capabilities of this arduino mega, we can use it as a control tool (substitute) for the OCR and GFR settings. And the fault current can be detected with a sensor in the form of a current sensor. The current felt by the sensor will be input to be processed by the Arduino Mega. Processed results will be issued through predetermined pins. This output will affect and channel commands to the simulation circuit.

II. DESIGN MODEL

2.1 How the Tool Works

This tool is a simulation tool using the minimum Arduino system for controlling OCR and GFR interference with definite characteristics. In this tool refers to some equipment for example the work of CT transformers and protection relays which are replaced by current sensors ACS712 and arduino mega. When the ACS712 sensor detects a current that exceeds the nominal current from the transformer or according to the settings of the program, Arduino will process the data and then take action in the form of an order to the PMT or Recloser contactor to immediately open or reclose depending on the function and criteria of the contactor being used. aimed at. The PMT contactor and recloser work here are replaced by AC magnetic contactors. The following is a specification of how the equipment works in the simulator.

2.2 Step Down Power Transformer 220 VAC/110 VAC

The transformers used here are 3 (three) step down power transformers with the ability to change the input voltage from 220 VAC to 110 VAC. Both the input/primary and output/secondary

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sides are connected to a 3-phase transformer. The effect that exists by using the 1-phase or 3-phase side is theemergence of an inter-phase voltage whose magnitude is the voltage (V) multiplied by 3.
As for the current flowing in each phase the same. There is no difference between the current measured in the 1 phase and 3 phase measurement experiments

The current sensor used is ACS712 5A. That is a type of current sensor that can detect both AC and DC currents. This sensor works on the working principle of converting the output voltage into current. The comparison of current and voltage can be seen in the graph below:

2.3 Current SensorACS712 .

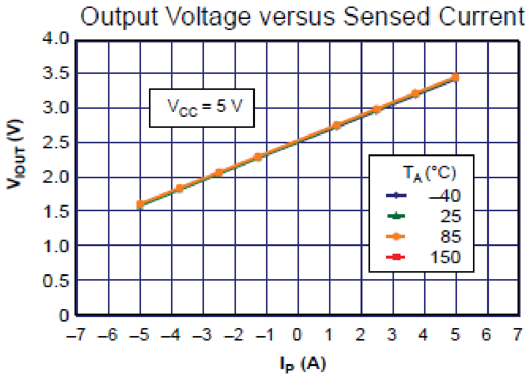

Figure 1 Graph between Output Voltage and Current Sensor Current ACS712

So, the current that is read in the Arduino comes from the calibration of the voltage and current which more or less the result will be like the table below:

Table 1 Calibration of Current and Voltage

Read Current (A)	Voltage (Volt)
0,45	2,7
0,6	2,77
1,13	2,9

2.4 ArduinoMega

Arduino is a product name for a free microcontroller minimum system design. The advantage of Arduino is that Arduino has its own programming language, the programming used is C language which has been simplified with simple functions. Arduino also has a boot loader program that has been embedded in its microcontroller, which serves to bridge the arduino software compiler with the microcontroller which functions to control it in a small form.

Arduino Mega 2560 is a microcontroller board based on the ATmega2560. The Arduino Mega2560 has 54 digital input/output pins, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. To activate the Arduino, it can be done by connecting the power jack to the computer via a USB cable or connecting the power to an AC-DC adapter or battery. Figure 2.30 shows the front view of the Arduino Mega R2560 board. Table 2.3 shows a simple specification of the Arduino Mega R2560 device.

Figure 2. Arduino Mega 2560 . Physical Front View

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(Source : datasheet Arduino Mega 2560)

2.5 Current Sensor ACS712 .

Figure 3 Physical Sensor ACS712

(Source : datasheet ACS712 5A)

ACS712 is an allegro applied current sensor that works based on the hall effect. In general, current measurement uses a resistor that is connected in series to the load and converts the current flow into voltage and then proceeds to CT (Current Transformer). By allegro, the function of the resistor and CT is replaced by the use of the hall effect.

In the use of the hall effect, the current flow will cause a magnetic field that induces the dynamic offset cancellation portion of the ACS712. Because the induction produced is quite weak, it will be amplified first by the amplifier and through the filter (pin 6) and then output as output through pin 7.

2.6 Magnetic Contactors

Magnetic contactor or magnetic switch is a switch that works based on magnetism. This means that this switch works when there is a magnetic force. Magnets function as attractor and release contacts. A contactor must be capable of carrying current and breaking current under normal operating conditions. The normal working current is the current that flows as long as the disconnection does not occur. A magnetic coil contactor can be designed for direct current (DC current) or alternating current (AC current). This AC current contactor has a short circuit ring attached to the magnetic core, the point is to keep the magnetic current continuous so that the contactor can work normally. While the magnetic coil designed for DC current is not installed short circuit ring.

2.7 Proteus Simulator Circuit

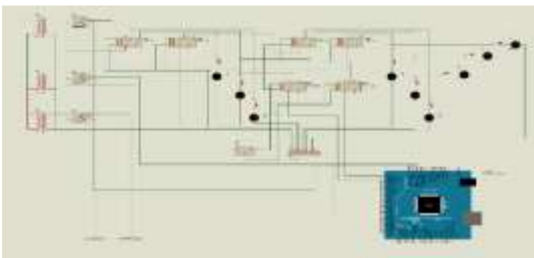

Figure 4. Circuit of Simulation Tools in Proteus

2.8. Tool Design Results

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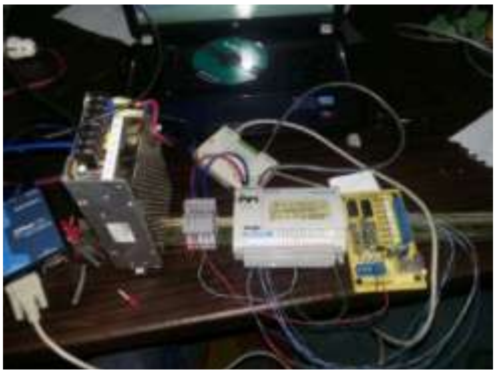

Figure 5. Programming for relay drivers

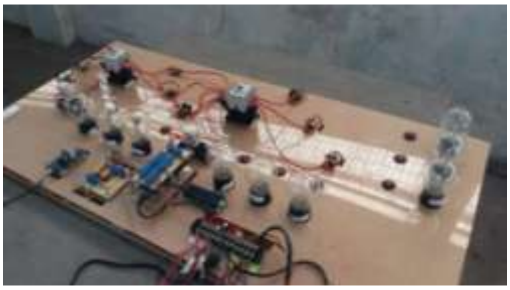

Figure 6. Complete Toolkit Installation

III. TESTING AND MEASUREMENT

3.1 Calculation of Determination of Fault Current Settings

In determining the action for a disturbance, it is better to know the origin of the setting in terms of the origin of the fault current calculation. For testing tools, data is needed for setting PMT and recloser for OCR and GFR disturbances. Here are the required data:

1. Transformer Data - 60 MVA
VektorgrupYNyn
Impedansi 13,32%
Rasio CT
CT incoming 20 kv = 2000: 1
CT outgoing 20 kv = 400 :1
Transformer nominal current
Side 150 kV In150 = transformer capacity /√3. Kv = 60.000/ √3.150 = 230,94A
Side 20 kV In20 = transformer capacity /√3. Kv = 60.000/ √3.20 = 1732,051A

2. Feeder Data 20 kV
Feeder length 6 = 12.512 km
Feeders use wire conductors AAAC diameter 240 mm
Positive sequence impedance (Ω/km) R1 = 0,1344 X1 = 0,3158
Zero order impedance (Ω/km) R1 = 0,3631 X1 = 1,6180
PMT and Recloser Area = 40% dan 80%

3.2 Working Settings on the Simulation Tool

From the above example, the noise setting is used for the standard inverse type. While here the author will use the definite time type. There is no difference in the reference fault current calculation. The difference that exists when viewed from the curve, is only in the handling time, for definite time faults it is the same regardless of the magnitude of the fault current..

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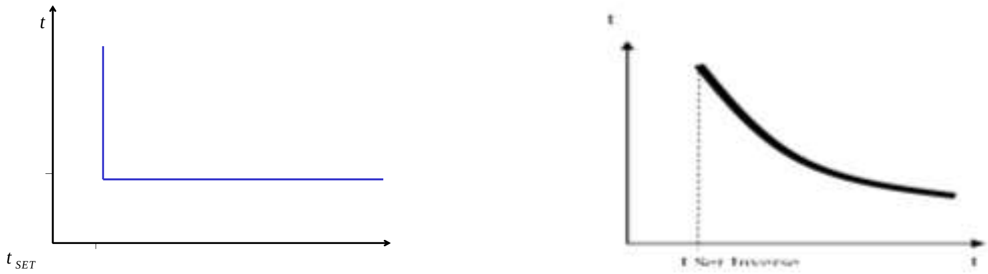

a) Definite Time b) Standard Inverse

Figure 7 Comparison of the Characteristics of Definite Time and Standard Inverse

The data that can be taken and used as calculations for this simulation equipment are:

• 3 step down transformers 220 VAC / 110 VAC 100 watts of power. Then the nominal current per transformer:

P = V. I. cos pi

100 = 110. I. 0,8

I = 1,136 A

• 80% transformer efficiency so that

In = 80% x 1,136

In = 1,08

• Current to be charged

1. 100 watt lamp
2. 60 watt lamp
3. 40 Watt lamp

From the calculations above, the reference for the disturbance that will be used in this simulation tool is obtained as follows:

Table 2 Major Crashes Simulator

Disturbance Location	Installed Load Power (Lamp)	Fault Reference Current (A)
disturbance 1	100 watt	1,136
disturbance 2	60 watt	0,678
disturbance 3	40 watt	0,45

3.3 Measurement

The steps for measuring the tool are as follows:

1. Prepare measurement tools and materials
2. Install the simulation equipment on the mockup.
3. Setting up communication to Arduino.
4. Installing the power supply used, namely the 12V and 220VAC power supply
5. Installing the load on the socket in the mockup

3.4 Measurement Results

Tests are carried out to measure the current for each load per phase which is simulated as a disturbance

.

Table 3. Measurement of 1 Phase R Interference

Trial to	Current (mA)	Voltage (V)
1.	1613	120
2.	1230	110
3.	1336	110
4.	1100	120
5.	1621	110
average	1380	114

• Measurement of the 1 S Phase fault

Table 4. Measurement of 1 Phase S Interference

Trial to	Current (mA)	Voltage (V)
1.	1711	110
2.	1830	110
3.	1320	110
4.	1421	110
5.	1102	110
average	1476,8	110

• Measurement of the 1 T Phase fault

Table 5. Measurement of 1 Phase t Interference

Trial to	Current (mA)	Voltage (V)
1.	892	110
2.	1001	110
3.	1304	110
4.	989	110
5.	1571	110
average	1151,4	110

3.5 Comparison of Measurements Against Calculations

interference formula analysis reference
Lamp power = 100 watt
Cos pi = 0,8
P = V.I.cos pi
100 = 110. I. 0,8
I = 1,136 A

Table 6 Comparison of Measured with Calculated Disturbance 1

Phasa	Current (Ma)		Difference Ratio (%)	Voltage (V)		Difference Ratio
	Measurable	Counted		Measurable	Counted	
R	1380	1136	1,21	114	110	1,036
S	1476,8	1136	1,3	110	110	0
T	1151,4	1136	1,01	110	110	0

IV. CONCLUSION

In designing this tool, the authors get several conclusions that can be drawn during the design and manufacture of this final project:

1. Arduino Mega can be used as a minimum control system for OCR and GFR interference.
2. The definite time characteristic is a characteristic with instant time setting that can be demonstrated in a simple hardware design.
3. The existence of voltage instability and incoming stray currents can be an obstacle in the current and voltage measurement process.
4. The use of AC contactors, current sensors ACS712 and the minimum system arduino mega are very compatible in the manufacture of this simulator as seen from the small ratio of current and voltage measurements.

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