

SIMULASI PROTEKSI OVERLOAD DENGAN RELAY BERBASIS ARDUINO MEGA 2560 DAN ANTARMUKA VISUAL BASIC .NET

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ABSTRAK

Perkembangan teknologi sistem proteksi tenaga listrik menuntut ketersediaan media pembelajaran yang aman, murah, dan representatif untuk mendukung pemahaman konsep *overload* serta respons peralatan proteksi. Penelitian ini merancang dan mengimplementasikan simulator proteksi *overload* berbasis Arduino Mega 2560 yang diintegrasikan dengan antarmuka *Human-Machine Interface (HMI)* pada Visual Basic .NET. Sensor tegangan *ZMPT101B* dan sensor arus *ZMCT103C* dipasang pada jalur (R-S-T) dan dua *Section* beban untuk mengukur parameter kelistrikan secara real-time. Data hasil pengukuran dikirim melalui komunikasi *Serial RS-232*, ditampilkan pada *HMI*, serta dicatat otomatis ke dalam berkas .xlsx. Ketika arus melebihi ambang yang ditetapkan, mikrokontroler memicu relay *Sectionalizer* untuk memutus sirkuit, jika gangguan berulang hingga empat kali, relay *recloser* akan aktif dan memadamkan seluruh saluran. Pengujian akurasi sensor tegangan menghasilkan error rata-rata 0,42% (keberhasilan 99,58%), sedangkan sensor arus memperoleh error rata-rata 1,18 % (keberhasilan 98,82 %). Uji respons proteksi menunjukkan trip *Sectionalizer* dan *recloser* berlangsung tepat waktu sesuai logika terprogram, serta sistem mampu merekam seluruh peristiwa tanpa kehilangan data. Antarmuka grafis menyediakan kontrol *overload* manual, visualisasi single-line diagram, serta ekspor log untuk analisis. Hasil ini membuktikan simulator layak digunakan sebagai trainer sistem proteksi tenaga listrik, memberikan pengalaman nyata pengoperasian *Sectionalizer* dan *recloser*.

Kata Kunci: *HMI*, Visual Basic .NET, Simulasi, Arduino Mega 2560, Komunikasi *Serial RS-232*

OVERLOAD PROTECTION SIMULATION WITH ARDUINO MEGA 2560- BASED RELAY AND VISUAL BASIC .NET INTERFACE

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ABSTRACT

The evolution of technology in electrical power system protection requires the availability of safe, affordable, and representative learning media to support the understanding of overload concepts and the response of protection equipment. This research designed and implemented an overload protection simulator based on the Arduino Mega 2560, integrated with a Human-Machine Interface (HMI) in Visual Basic .NET. ZMPT101B voltage sensors and ZMCT103C current sensors were installed on the (R-S-T) lines and two load sections to measure electrical parameters in real-time. The measured data is transmitted via RS-232 Serial communication, displayed on the HMI, and automatically recorded into an .xlsx file. When the current exceeds a set threshold, the microcontroller triggers the sectionalizer relay to disconnect the circuit. If the fault recurs up to four times, the recloser relay will activate and de-energize the entire line. Testing of the voltage sensor accuracy yielded an average error of 0.42% (99.58% success), while the current sensor achieved an average error of 1.18% (98.82% success). Protection response tests showed that the sectionalizer and recloser trips occurred in a timely manner according to the programmed logic, and the system was able to record all events without data loss. The graphical interface provides manual overload control, a single-line diagram visualization, and log export for analysis. These results prove that the simulator is feasible for use as a trainer for electrical power protection systems, providing a realistic experience in operating sectionalizers and reclosers.

Keywords: HMI, Visual Basic .NET, Simulation, Arduino Mega 2560, RS-232 Serial Communication