PROJECT ABSTRACT

Motorized Autotransformer Voltage Regulator with Preset Control

A servo voltage regulator built around a toroidal variac: a DC gear motor drives the brush arm under Arduino control to hold the output at 220, 230 or 240 V presets automatically, with manual jog mode and limit-switch protection.

01. Title

Motorized Autotransformer Voltage Regulator with Preset Control

02. Introduction / Background

Mains voltage in many areas swings well outside the nominal 230 V, stressing appliances and lab equipment. A classic solution is the servo-controlled stabilizer: a motor-driven autotransformer (variac) whose brush is moved until the output voltage is correct. Unlike tap-changing stabilizers that jump in steps, a variac gives smooth, stepless correction. This project builds that servo loop at bench scale: a toroidal variac, a gear motor, an Arduino controller and three preset voltage buttons.

03. Problem Statement

Voltage fluctuation damages equipment and most student-built regulators are either manual variacs or relay tap-changers with coarse steps. There is a need for a demonstrable closed-loop servo regulator that shows feedback control theory (sensing, comparison, actuation, deadband) working on real mains voltage.

04. Objectives

- Drive a toroidal variac's brush arm with a DC gear motor and reduction gearing.
- Regulate the output to selectable presets of 220, 230 and 240 V.
- Close the loop with output-voltage feedback and a deadband to prevent hunting.
- Provide a manual jog mode for the brush in both directions.
- Protect the mechanism with end-of-travel limit switches.
- Display the live output voltage on a digital meter.

05. Proposed Methodology

The output voltage is stepped down, rectified and scaled to the Arduino's ADC range. The firmware compares the measured voltage with the selected preset: if the output is low it drives the L298N motor driver forward, if high it reverses, and inside a ±2 V deadband it stops the motor to avoid hunting around the setpoint. Preset selection is by three push-buttons; a toggle switches between AUTO and MANUAL jog. Limit switches at both ends of brush travel cut the motor drive to protect the winding and mechanism. A lamp load demonstrates regulation as the input is varied.

06. System Architecture / Working

The power stage is a 500 VA toroidal autotransformer (0–250 V) with its rotating brush coupled through gears to a 12 V DC gear motor mounted on a 3D-printed bracket. The control box holds the Arduino Uno, L298N driver, sensing transformer and rectifier, the

digital output voltmeter, preset buttons and the AUTO/MANUAL toggle. Feedback wiring runs from the variac output back to the sensing stage, closing the servo loop.

07. Hardware / Software Requirements

- Toroidal autotransformer (variac), 0–250 V, 500 VA (demonstration unit).
- 12 V DC gear motor with reduction gearing and coupling arm.
- Arduino Uno; L298N dual H-bridge motor driver.
- Output-voltage sensing transformer + rectifier + divider.
- Digital AC voltmeter (panel instrument); preset push-buttons; AUTO/MANUAL toggle.
- End-of-travel limit switches; lamp load; control enclosure.
- Arduino IDE with the servo-regulation firmware.

08. Expected Outcomes

- Automatic regulation to the selected preset within about ±2 V (design target) for slow input variations.
- Full brush travel in roughly 3–5 seconds (expected), demonstrating servo response time.
- No hunting or oscillation thanks to the deadband and limit switches.
- A clear, physical demonstration of closed-loop feedback control on real AC voltage.

09. Applications

- Control-systems and power-electronics laboratories.
- Demonstrating servo mechanisms and feedback theory.
- Prototype for custom lab-bench variable AC supplies.
- Voltage conditioning for sensitive demo equipment.

10. Future Scope

- Add an LCD showing setpoint, measured voltage and motor state.
- Faster correction with a higher-RPM motor and PID control.
- Input brownout ride-through with a small UPS stage.
- Three-phase servo stabilizer using three ganged variacs.