Low-Power Induction Heater using ZVS Oscillator

A low-power induction heater built on the classic ZVS (zero-voltage-switching) oscillator: two MOSFETs drive a hand-wound copper work coil, heating a metal workpiece contactlessly via eddy currents, with live temperature display. Delivered built-to-order with working prototype, coil-winding guide, tuning procedure, safety guide, report, PPT and viva kit.

Title

Low-Power Induction Heater using ZVS Oscillator — resonant power electronics demonstrating eddy-current heating.

Introduction / Background

Induction heating is how industry hardens gears and solders without flame: a high-frequency magnetic field induces eddy currents in the metal, and the metal's own resistance turns those currents into heat. The ZVS oscillator is the hobbyist-grade route to the same physics — a self-resonating push-pull stage that switches its MOSFETs at zero voltage, keeping switching losses low enough for a student build.

This project constructs one: a center-tapped hand-wound copper work coil, two power MOSFETs with heatsinks and a fan, selectable resonant tank capacitors, and a 12–24 V supply. A K-type thermocouple with a MAX6675 module and an LCD show the workpiece temperature climbing, so the demo is quantitative, not just visual. The report works through resonance, skin effect and eddy-current heating, and the safety section is treated as first-class content, not a footnote.

Problem Statement

Power electronics is often taught with idealized waveforms; students rarely wind a real resonant tank, probe a real switching node, or handle real thermal management. This project provides a supervised, low-power induction-heating rig where resonance is tuned by hand, heating rate is measured against tank selection, and every high-current and thermal hazard is addressed in a written safety routine.

Objectives

- Build a ZVS push-pull resonant oscillator with two IRFP250-class N-MOSFETs, heatsinks and a cooling fan.
- Hand-wind a center-tapped copper-tube work coil and demonstrate the inductance–capacitance relationship.
- Heat small steel workpieces (design target: bolt/nut class, under approx. 50 g) contactlessly via eddy currents at a resonant frequency of approx. 30–80 kHz (design target, tank dependent).
- Display live workpiece temperature (K-type thermocouple + MAX6675, 0–400 °C datasheet range) and supply voltage on a 16x2 LCD.
- Provide selectable tank capacitors so the student tunes resonance and observes the effect on heating rate.

- Protect with an input fuse and enforce a supervised-demo safety routine with mandatory cool-down.
- Deliver the complete student kit: prototype, display firmware, wiring docs, coil guide, tuning and test procedures, safety guide, report, PPT and viva Q&A.;

Proposed Methodology

The system is developed in three stages. (1) Power stage: the ZVS board is assembled — MOSFETs on heatsinks, tank capacitors, gate drive network — and the work coil is hand-wound and center-tapped. (2) Instrumentation: the K-type thermocouple and MAX6675 feed an Arduino Nano that displays live temperature on the LCD. (3) Characterization: the student varies the tank capacitance and supply voltage (within the 12–24 V, approx. 10 A fused ratings) and records workpiece temperature vs time, producing a resonance-vs-heating-rate study from their own data. All heating figures are buyer-measured; no heating performance is claimed in advance.

System Architecture / Working

On switch-on the oscillator self-starts, alternately driving the two MOSFETs in push-pull; the tank capacitors and coil inductance set the resonant frequency. The high-frequency alternating magnetic field inside the work coil induces eddy currents in the inserted steel workpiece, and the workpiece's own resistance converts them to heat. The thermocouple pressed near the workpiece feeds the MAX6675; the Arduino displays live temperature on the LCD. The student records heating curves at different tank settings and supply voltages for the report's resonance study.

Hardware / Software Requirements

- ZVS oscillator board (2x IRFP250-class N-MOSFETs, heatsinks, cooling fan)
- Hand-wound copper-tube work coil, center-tapped
- Selectable resonant tank capacitors (104J/630V class)
- K-type thermocouple + MAX6675 module
- Arduino Nano + 16x2 LCD (temperature display)
- 12–24 V DC supply, input fuse
- Arduino IDE (C/C++ firmware for display)

Expected Outcomes

A working low-power induction heater that heats small steel items contactlessly under supervision.

Student-measured temperature-vs-time curves at multiple tank settings — a genuine resonance study from their own data.

A written safety guide (burn, EMI, supervision, cool-down) treated as a graded deliverable.

Applications

- Teaching resonant converters, electromagnetic induction and power-electronics safety.
- Demonstrating skin effect and eddy-current physics on real hardware.
- A viva-ready rig with a measurable, plotted experiment.

Future Scope

- Closed-loop temperature control with a setpoint and duty modulation.

- Current-sense-based resonance auto-tracking study.
- Larger tank and water-cooled coil as a supervised extension (safety review required).
- EMI mapping study around the work coil.