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This PCB design targets an automatic water temperature control system for 1 liter of purified water in an enamel vessel. The system allows manual temperature setting within 40～90℃ (1℃ resolution) and maintains the set temperature stably even when ambient temperature drops, with high precision and responsive control performance.

Key Performance Requirements

1. Temperature setting range: 40～90℃ (minimum resolution: 1℃), calibration accuracy ≤1℃
2. Static temperature control error ≤1℃ under ambient temperature decrease
3. Real-time water temperature display via decimal digital tube
4. Optimized control method to minimize overshoot and regulation time (for set temperature changes e.g., 40℃ → 60℃)
5. Static temperature control error ≤0.2℃ (core precision requirement)

3. System Architecture

The single-chip microcomputer control system consists of four core modules:

- **Keyboard & Display Circuit**: Drives decimal digital tubes for temperature display, with 2051 MCU as the core (shared I/O port design reduces hardware cost).
- **Microcontroller Control Core**: 89C52 MCU (8KB program memory, 256-byte data memory) – no external memory expansion required, simplifying hardware design.
- **Temperature Sampling Circuit**: Converts temperature signals to electrical signals for MCU processing.
- **Temperature Control Circuit**: Executes heating control based on MCU instructions.

(Insert Figure 2-1: Block Diagram of the Microcontroller Control System here)

4. Core Component Selection & Design

4.1 Temperature Sensor (AD590)

Selected via comparative analysis of three options:

- Platinum resistance: High linearity/stability but costly (rejected)
- Thermistor: Low cost but poor linearity (rejected)
- AD590 (two-terminal integrated current sensor):

- Measurement range: -50℃ to +150℃, full-scale error ±0.3℃ (±0.01℃ at 5–10V stable power supply)
- Linear output: 1μA current change per 1℃ temperature variation (308.2μA at 35℃, 368.2μA at 95℃)
- Compact size and stable performance (meets core precision requirements)

4.2 A/D Conversion Circuit (ADC0804)

- 8-bit A/D converter with 0–5V input range, conversion speed <100μs, accuracy 0.39%
- Parameter configuration:
  - 7812 three-terminal regulator (12V output) to achieve zero Ui potential (Ib = 308.2μA)
  - Potentiometer values: R2 = 30kΩ, R1 = 10kΩ (optimized for 35–95℃ temperature range)
  - Precision resistors: R5 = 81kΩ, R4 = 30kΩ (calibrated for 95℃ AD590 output current of 368.2μA)

(Insert Figure 2-2: Signal Acquisition Circuit here)(Insert Figure 2-3: A/D conversion circuit here)

4.3 Temperature Control Circuit

- Core components: MOC3041 optocoupler (400V rating, zero-crossing trigger) + BTA12 triac
- Protection design: 100Ω resistor + 0.01μF capacitor (triac overvoltage/overcurrent protection)
- Control logic: MCU outputs signals via 74LS07 driver to trigger MOC3041, controlling triac on/off for electric stove heating

(Insert Figure 2-4: Partial control circuit here)

4.4 Host Control Part

This section constitutes the core circuitry, with the system's control implemented using the 89C52 microcontroller. The microcontroller features 8KB program memory and 256-byte data memory, eliminating the need for external expansion of program or data storage. This significantly reduces the system's hardware requirements.

(Insert Figure 2-5: Host control section here)

4.5 Keyboard and Numeric Display Section

In designing the keyboard/display circuit, we use the 2051 microcontroller as the core control unit. The microcontroller features a full-duplex serial port, which facilitates system control and display functions. The keyboard/display interface circuit is shown in Figure 2-6. In Figure 3-4-1, the P1 pin of the 2051 microcontroller is connected to the 8 pins of the digital display, enabling easy decoding of the display to show the designer's required values, decimal points, symbols, and other data.

The P3.3, P3.4, and P3.5 pins of the 2051 microcontroller are connected to the 3-8 decoder 74L138. The decoder's output is directly linked to the control terminals of eight digital displays and the keyboard. The keyboard and display share the same port, significantly reducing the microcontroller's I/O load and hardware costs.

(Insert Figure 2-6: Keyboard/display interface circuit here)(Insert Figure 3-4-1: Display decoding circuit here)

5. PCB Manufacturing Advantages with PCBINQ

We specialize in custom PCB manufacturing for temperature control systems, with capabilities to:

- Optimize PCB layout for AD590/ADC0804 signal stability (reduce noise interference)
- Ensure high-precision component matching (meet 0.2℃ static error requirements)
- Provide DFM check to avoid manufacturing defects for 89C52/2051 MCU circuits
- Support rapid prototyping and mass production for industrial temperature control applications

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