

Smart Ultrasonic Humidifier – Design Explanation

1. Introduction

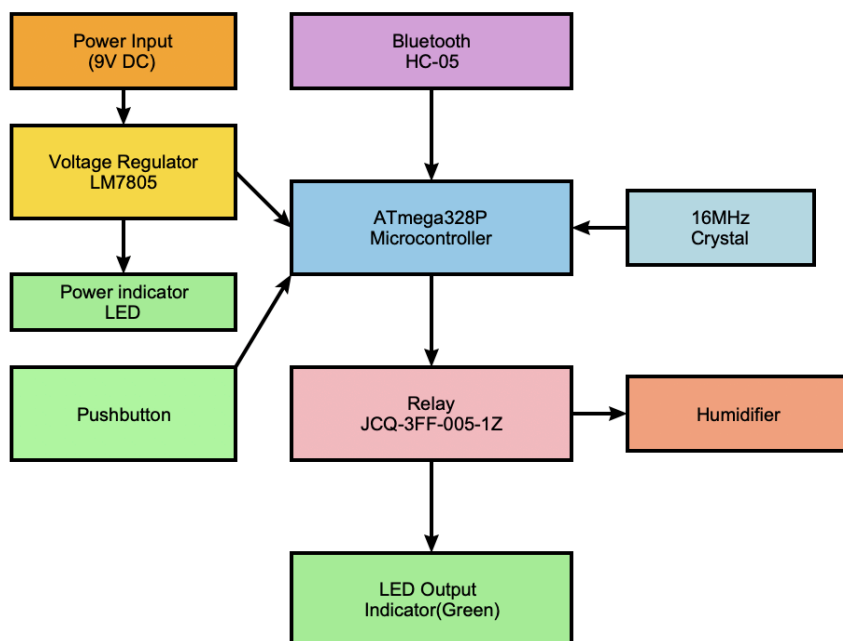
This design presents a production-ready circuit for a smart ultrasonic humidifier with dual control: manual push-button and Bluetooth via an HC-05 module. The core of the system is the ATmega328P microcontroller, chosen for its balance between performance, I/O flexibility, low power consumption, and widespread development support (especially via the Arduino environment). The device is designed to switch a relay that powers the ultrasonic humidifier module, offering intelligent and remote operation.

2. Components

Component	Specification / Value	Footprint
Microcontroller	ATmega328P	DIP-28_W7.62mm
Voltage Regulator	LM7805 (TO-220 package)	SOT_SMD:SOT-223
Crystal Oscillator	16 MHz	Crystal_HC49-4H_Vertical
Capacitor	22pF	Capacitor_SMD:C_0805_2012Metric_Pad1.18x1.45mm_HandSolder
Capacitor	100nF	Capacitor_SMD:C_0805_2012Metric_Pad1.18x1.45mm_HandSolder
Resistor	330Ω	Resistor_SMD:R_1206_3216Metric_Pad1.30x1.75mm_HandSolder
Resistor	1kΩ	Resistor_SMD:R_1206_3216Metric_Pad1.30x1.75mm_HandSolder

Resistor	2k Ω	Resistor_SMD:R_1206_32 16Metric_Pad1.30x1.75m m_HandSolder
Resistor	10k Ω	Resistor_SMD:R_1206_32 16Metric_Pad1.30x1.75m m_HandSolder
Push Button Switch	Tactile switch	SW_PUSH_6mm
Relay	JQC-3FF-005-1Z	Relay_SPDT_Hongfa_JQ C-3FF_0XX-1Z
LED	Red	LED_THT:LED_D5.0mm
LED	Green	LED_THT:LED_D5.0mm
Connector Header	2-pin (for power/relay)	PinHeader_1x02_P2.54m m_Vertical
Connector Header	4-pin (for Bluetooth)	PinHeader_1x04_P2.54m m_Vertical(Female)

Block Diagram:



3. Microcontroller Selection

The **ATmega328P** is an 8-bit AVR microcontroller featuring:

- 32KB Flash, 2KB SRAM, and 1KB EEPROM
- 23 programmable I/O lines
- UART, SPI, and I²C interfaces
- 16 MHz maximum operating frequency

It provides sufficient memory for control logic and Bluetooth communication and has a built-in UART which is ideal for interfacing with the HC-05 Bluetooth module.

4. Power Supply Section

The circuit operates from a **regulated 5V power source**, supplied via an **LM7805 voltage regulator (TO-220)**. This linear regulator steps down input voltage (typically 7–12V DC) to a constant 5V for the microcontroller and other 5V components.

Capacitors:

- Two **22pF capacitors (C1, C2)** are connected to the 16 MHz crystal oscillator to stabilize the clock signal.
 - A **100nF decoupling capacitor (C3)** is placed near the microcontroller to filter power supply noise.
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5. Oscillator Circuit

A **16 MHz crystal oscillator (Y1)** provides the external clock necessary for precise timing, UART communication, and PWM control.

6. Control Section

There are **two push buttons (SW1 and SW2)** connected to the ATmega328P. These serve the following functions:

- SW1: Manually toggle the relay (turn humidifier ON/OFF)
- SW2: Reset

SW1 has a **10k Ω pull-up resistor (R3)** and **SW2** has a **10k Ω pull-down resistor (R5)** to ensure defined logic levels when not pressed.

7. Output Control (Relay Interface)

The **ultrasonic humidifier** is controlled via a **Relay (JQC-3FF-005-1Z) 5v Module** driven by the ATmega328P through a control pin digital High(5v). The relay isolates and safely switches the higher power supply to the ultrasonic humidifier.

Resistors in Relay Circuit:

- **330 Ω resistors (R4)** limit current to the LEDs.
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8. Indicators (LEDs)

Two LEDs provide system status:

- **Red LED (D1):** Power indicator or system ON state
 - **Green LED (D2):** Humidifier ON status or Bluetooth active
- The LEDs are connected via **330 Ω resistors** to limit current and avoid damage.
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9. Communication Interface

While the Bluetooth module (e.g., **HC-05**) is not explicitly shown in the PCB screenshot, the layout shows headers (J1,Female connector) that likely include UART TX/RX pins. The HC-05 is connected to these to enable smartphone-based ON/OFF control. The microcontroller communicates with it via UART.

10. Connector Headers

- **J1:** Likely for UART communication (Bluetooth and TTL code upload)
- **J2:** Power input
- **J3:** Output to relay(Humidifier)

These headers simplify programming, debugging, and module interfacing.

11. Software Logic and Structure

The firmware handles two primary control methods:

1. Manual Button Debouncing and Toggling:

- A software debounce algorithm ensures noise-free button presses
- The output pin state toggles only when a clean transition is detected

2. Bluetooth Serial Command Parsing:

- Serial commands are read via UART
- `'1'` sets the relay output HIGH
- `'0'` sets it LOW

The output state is always synchronized with user inputs, regardless of the control source.

12. Optimization for Production

This design balances cost, scalability, and ease of manufacture:

- **Low component count** minimizes cost
- Use of **standard, through-hole components** simplifies prototyping

- Can easily be adapted for **SMD** layout for mass production
- Open headers allow integration with sensors (e.g., DHT11/22 for humidity sensing)

Conclusion

The Smart Ultrasonic Humidifier is a robust, scalable, and cost-effective system suitable for smart home applications. Its dual-mode control system, combined with a clean PCB layout and thoughtful power management, makes it suitable for consumer deployment or further integration into IoT ecosystems.

Key Strengths:

- Reliable and low-power ATmega328P controller
- Dual-mode control (button and Bluetooth)
- Safe switching through a relay
- Visual status indication through LEDs
- Modular and well-structured PCB layout