User Manual: Watermeter Controller (ESP32-C6 Based)

Overview

This device is a multi-purpose environmental and flow controller based on the ESP32-C6-MINI-1 microcontroller. It supports temperature sensing via NTC thermistors and DS18B20/DHT21, pulse input from a Hall flow sensor, PWM input and output via optocouplers, and relay control.

Features

- USB-C interface with ESD and CC protection (USB-CDC/JTAG support)
- Power input via 5V USB or external source (via K7805-500R3 regulator)
- 4 x NTC analog temperature inputs (10k pull-up, RC filtered)
- 1 x DHT21 or DS18B20 digital sensor input
- 1 x Hall sensor (flow meter) pulse input
- 1 x PWM input (optically isolated)
- 1 x PWM output (optically isolated)
- 2 x Relay outputs (5V coils)
- 2 x LED indicators on GPIO22 and GPIO23
- External I/O connector for GPIOs

Power

- **Primary Input**: +5V via USB-C connector
- **Regulated Outputs**:

    - +5V rail from K7805-500R3 module
    - +3.3V LDO (AMS1117 or similar) for ESP32-C6 and peripherals
- **Power Flags**: Defined for ERC compliance

Microcontroller

- **Part**: ESP32-C6-MINI-1
- **GPIO Assignments**:
    - IO0–IO9: External connector
    - IO3: DHT21 or DS18B20 input
    - IO4–IO7: NTC analog inputs (with low-pass filters)
    - IO5: Hall (flow) input (10k pull-up + 2.2nF filter)
    - IO6: PWM Input (via optocoupler TLP2361)
    - IO8: PWM Output (via optocoupler TLP2361)
    - IO18: Relay1 control (via NPN transistor)
    - IO19: Relay2 control (via NPN transistor)
    - IO20–IO21: General-purpose GPIOs
    - IO22: LED1 indicator (with 20Ω current limiting resistor)
    - IO23: LED2 indicator (with 15Ω current limiting resistor)

USB-C Interface

- **Connector**: USB-TYPE-C-31-M-12
- **Protection**:

    - TVS Diode: PESD5V0S1UL
    - CC1/CC2: 5.1k pull-downs for device mode
    - ESD: Series resistors (22Ω)
- **Data Lines**: Connected to IO19/IO20 (USB_D+/USB_D-)
- **Shield**: Tied to GND

Temperature Inputs

NTC:

- 4 inputs (IO4–IO7)
- 10k pull-up resistors
- RC filters per channel: 4.7k + 0.1 µF

Digital (DHT21 / DS18B20):

- Shared GPIO: IO3
- Pull-up: 10k to 3.3V

Flow Meter Input (Hall Sensor)

- GPIO: IO5
- Pull-up: 10kΩ
- Filter: 2.2nF capacitor

PWM Input

- GPIO: IO6
- Via optocoupler TLP2361 (DC2)
- Input resistor: 4.7kΩ
- LED current limit: 1kΩ
- 3.3V side pull-up: 4.7kΩ

PWM Output

- GPIO: IO8
- Drives TLP2361 (DC1) optocoupler
- LED side: 470Ω resistor
- Collector side: pull-up to 5V via 4.7kΩ

Relay Outputs

Relay1 (K1)

- GPIO: IO18
- NPN drive (Q1) with base resistor 1kΩ
- Flyback diode: 1N4148

Relay2 (K2)

- GPIO: IO19
- Same drive circuit as Relay1

LED Indicators

- **LED1** (D1): Connected to IO22 via 20Ω resistor to GND
- **LED2** (D2): Connected to IO23 via 15Ω resistor to GND
- Both LEDs light up when their respective GPIOs are set HIGH

External I/O Header (J9)

- Pins: IO0–IO9, GND, 3.3V
- For optional expansion

Notes

- All analog sensor lines are RC-filtered for noise rejection.
- All digital inputs/outputs are protected by series resistors or opto-isolation.
- Ensure no conflicting devices are connected to shared GPIOs.
- USB operation assumes TinyUSB or esp-usb-bridge firmware.

Recommended Firmware

- **Platform**: ESP-IDF or ESPHome
- **USB CDC/JTAG**: Enable `usb_serial_jtag` or TinyUSB stack
- **NTC Reading**: Use ADC + Steinhart-Hart or lookup table
- **PWM Measurement**: PulseIn or interrupt-based
- **Relay Logic**: Active HIGH to switch

Revision Control

- **File**: `watermeter.kicad_sch`
- **Sheet size**: A4
- **Version**: 1.0
- **Date**: [To be filled]