**Current Wiring Schematic**

This diagram shows how your control module (ESP32C3 + INA219 + Relay + Protections) is currently wired to drive and monitor a 24 VDC ballast.

+24VDC PSU ──┐

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│ PTC Fuse (RUEF200)

│ [PTC]

│ │

└──► VIN+ (INA219) ──┐

│ (internal shunt)

│

VIN– (INA219) ──► COM (Relay)

│

│ NO (Relay)

│

+24V Ballast

+24VDC PSU ──┐

│

│ DC-DC Buck/LDO Regulator

│ – In: +24V post-fuse

│ – Out: +3.3V (3V3 Bus)

│

–24VDC PSU ────────────────────────────────┐

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▼

Common GND /

Logic Ground

(ESP32, INA219, TVS, capacitor)

3.3V Regulator (from 24V) ───────────► 3V3 Bus

│

┌────────────┴────────────┐

│ │

VCC INA219 VCC ESP32C3

SDA (GPIO4) ────► SDA

SCL (GPIO5) ────► SCL

RELAY\_IN (GPIO6)

**Connector and Component Description**

* **24 VDC PSU**:
  + +24 V (black) → PTC fuse → VIN+ of INA219
  + –24 V (white/blue) → common GND
* **PTC Fuse** (RUEF200): series overcurrent protection on +24 V
* **TVS Diode (30 V)** (<https://www.aliexpress.com/item/32878977126.html>) and **330 µF/35 V Capacitor** (<https://www.aliexpress.com/item/1005006186858370.html>): placed in parallel between +24 V post-fuse and common GND
* **DC-DC Buck Converter / LDO Regulator** (<https://www.aliexpress.com/item/1005001629723875.html>):
  + Input: +24 V after PTC fuse
  + Output: +3.3 V (3V3 Bus) to power ESP32C3 and INA219
  + Must supply ≥500 mA with low ripple
* **INA219** (<https://www.aliexpress.com/item/1005006109458834.html>) (high-side current sense):
  + VIN+ → +24 V after PTC fuse
  + VIN– → COM of relay
  + VCC → +3.3 V
  + GND → common GND
  + SDA → GPIO4 (D4)
  + SCL → GPIO5 (D5)
* **3 V Relay Module** (<https://www.aliexpress.com/item/1005006334524742.html>):
  + COM → VIN– of INA219 (relay input)
  + NO → +24 V to ballast
  + VCC → +3.3 V
  + GND → common GND
  + IN → GPIO6 (D6), active LOW
* **ESP32C3 XIAO** (<https://www.aliexpress.com/item/1005006353129383.html>):
  + 3.3 V → powers relay VCC and INA219 VCC
  + GND → common GND
  + D4 (GPIO4) → SDA of INA219
  + D5 (GPIO5) → SCL of INA219
  + D6 (GPIO6) → IN of relay
* **Ballast (T5 UV Lamp)**:
  + +24 V → from NO of relay
  + –24 V → common GND (not via INA219)
  + Green/Chassis → chassis ground (not tied to logic GND)

**NOTE:**

+24VDC and -24VDC are drawn from the existing HVAC PCB rather than directly from the PSU.