Understanding TV SMPS: Basics, Working, Faults & Repairs

Chapter 1 – Introduction to SMPS

- What is SMPS?
  → A power supply that converts high-voltage AC (like 220V) into stable DC voltages (like 12V, 24V, 5V).
- Why SMPS instead of Linear Power Supply?
  → Smaller size, higher efficiency, less heat.
- Applications: TV, computer PSU, mobile chargers, LED TVs, monitors.

Chapter 2 – Block Diagram of a TV SMPS

Explain with a simple block diagram:

1. Wiring & Block Diagram
2. **AC Input & Filter** → Fuse, NTC, EMI filter, rectifier bridge, big capacitor (310V DC).
3. **PWM Controller & MOSFET** → Controls switching.
4. **High-Frequency Transformer** → Isolation + step-down.
5. **Secondary Rectification** → Fast diodes + capacitors.
6. **Feedback Circuit** → Optocoupler + TL431 reference IC.
7. **Protections** → OVP, OCP, UVLO.

Chapter 3 – Important Components

- **Bridge Rectifier & Capacitor** → Converts AC → 310V DC.
- **MOSFET (N-channel)** → Acts as main high-speed switch.
- **PWM IC (6 pins like UC3842 or CA888)** → Brain of SMPS.
- **Optocoupler (4 pins)** → Transfers feedback across isolation safely.
- **TL431 (3 pins)** → Precision shunt regulator, compares divided output with reference (2.5V).
- **Auxiliary winding** → Supplies PWM IC after startup.
- **Secondary side diodes & capacitors** → Provide usable DC voltages.

Chapter 4 – Flow of Power (Normal Working Sequence)

1. **AC Mains comes in** → Goes through fuse, EMI filter, rectified into ~310V DC.
2. **Startup Supply for PWM IC** → Comes from auxiliary winding or resistor divider until oscillation starts.
3. **PWM IC drives MOSFET** → MOSFET chops DC into high-frequency AC.
4. **Transformer transfers energy** → Secondary windings create 12V, 5V, 24V rails.
5. **Secondary rectification & filtering** → Schottky/fast recovery diodes + capacitors smoothen DC.
6. **Feedback loop** → TL431 + optocoupler control PWM duty cycle.

Chapter 5 – Feedback and Regulation

- Divider resistors scale down output voltage.
- TL431 checks if output > reference (2.5V).
- If too high → TL431 conducts → LED inside optocoupler glows → PWM duty reduced.
- If too low → LED dims → PWM increases duty.
- This keeps voltage stable under load.

Chapter 6 – Common Faults in TV SMPS

1. **No Power at All**
    - Check fuse, NTC, bridge rectifier, startup resistor.
    - Faulty MOSFET or shorted PWM IC.
2. **Standby Light but No Start**
    - Secondary side capacitor dried.
    - TL431 or optocoupler faulty.
    - Startup supply missing.
3. **Pulsing / Tick-Tick Sound**
    - Overload or short in secondary.
    - Optocoupler or divider resistors faulty.
4. **Overvoltage or Low Voltage Output**
    - Divider resistors drifted.

- Faulty TL431.
- Feedback loop unstable.

5. **Heating & Shutdown**
   - Bad MOSFET, poor heatsink.
   - Shorted diode on secondary.

Chapter 7 – Repairing CA888 Based SMPS

*"Now a special chapter: repairing SMPS with **CA888 PWM controller IC**.
This IC is commonly found in Chinese and budget TV power supplies. It has 6 pins: Vcc, Ground, Current Sense, Drive Output, Feedback, and Vref.

👉 **Typical problems with CA888 supplies:**

- If there is no startup at all, check if Vcc pin has around 12 to 18 volts. If missing, the startup resistor or auxiliary winding is faulty.
- If the MOSFET blows again and again, check current sense resistor and snubber network.
- If TV powers on but voltages fluctuate, check feedback loop: optocoupler, TL431, and divider resistors.
- If you get standby but no ON, the secondary filter capacitors may be weak.

👉 **How to repair step-by-step:**

1. First, check the primary side fuse and bridge.
2. Check the main MOSFET near CA888.
3. Measure Vcc at pin – if zero, startup supply missing.
4. Replace dry electrolytic capacitors in both primary and secondary.
5. Check optocoupler and TL431 – often cheap ones fail.
6. Finally, replace CA888 if still dead.

In most cases, 70% of SMPS faults are solved by changing electrolytic capacitors and the optocoupler with TL431."*

Chapter 8 – Conclusion

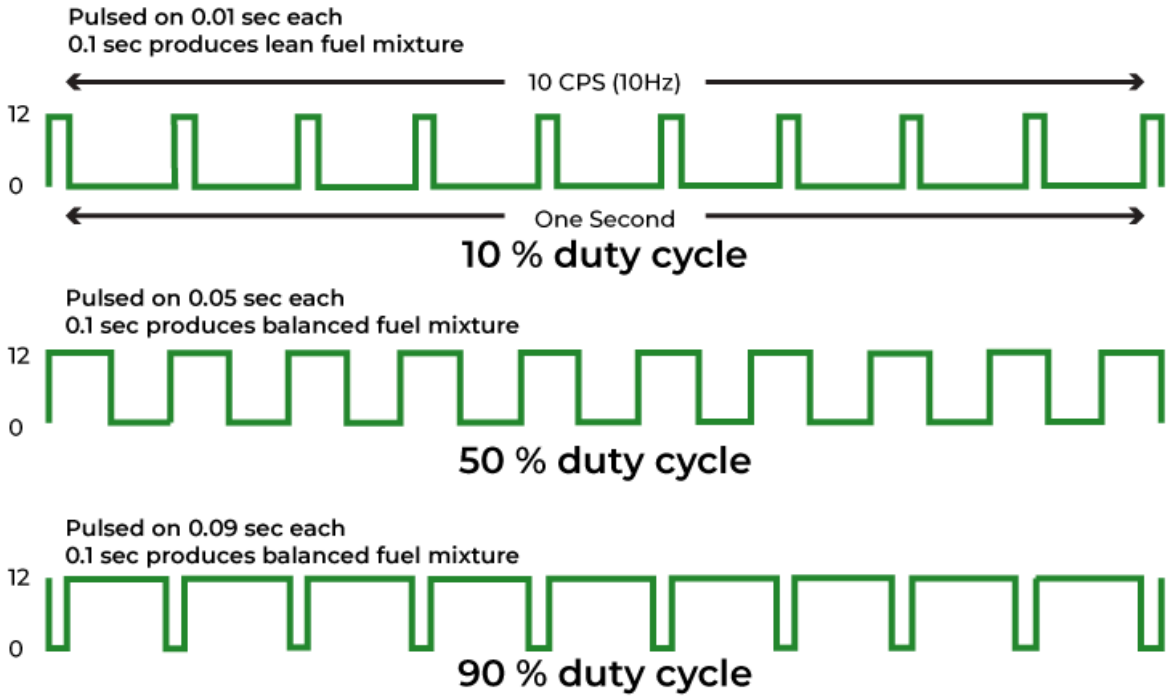
- SMPS is the **heart of modern TVs**.
- Once you understand the **blocks & flow**, troubleshooting becomes easy.
- Most faults are in **startup, MOSFET, or feedback loop**.
- With patience and safe methods, repairs are possible even at home

Chapter 1: SMPS

AC Transformers only scale up or Down AC voltage by ratio, i.e 11Kva to 220v etc

SMPS Steps Up or Step Down DC (or rectified AC) using high-frequency switching, i.e (320Vdc to 5v, 12v and 24-100vdc)

- **Switching**→ The input DC is rapidly switched **ON and OFF** pulses at a high frequency using **(MOSFET/IGBT)**.
- **Duty cycle** = percentage of time the MOSFET is ON in each switching period.
- More duty cycle → more energy pushed into the transformer → higher output **voltage.**
- Less duty cycle → less energy → lower output voltage.
- Most TV SMPS use a **switching frequency of 20 kHz to 100 kHz**, sometimes even up to **130–150 kHz** depending on design.



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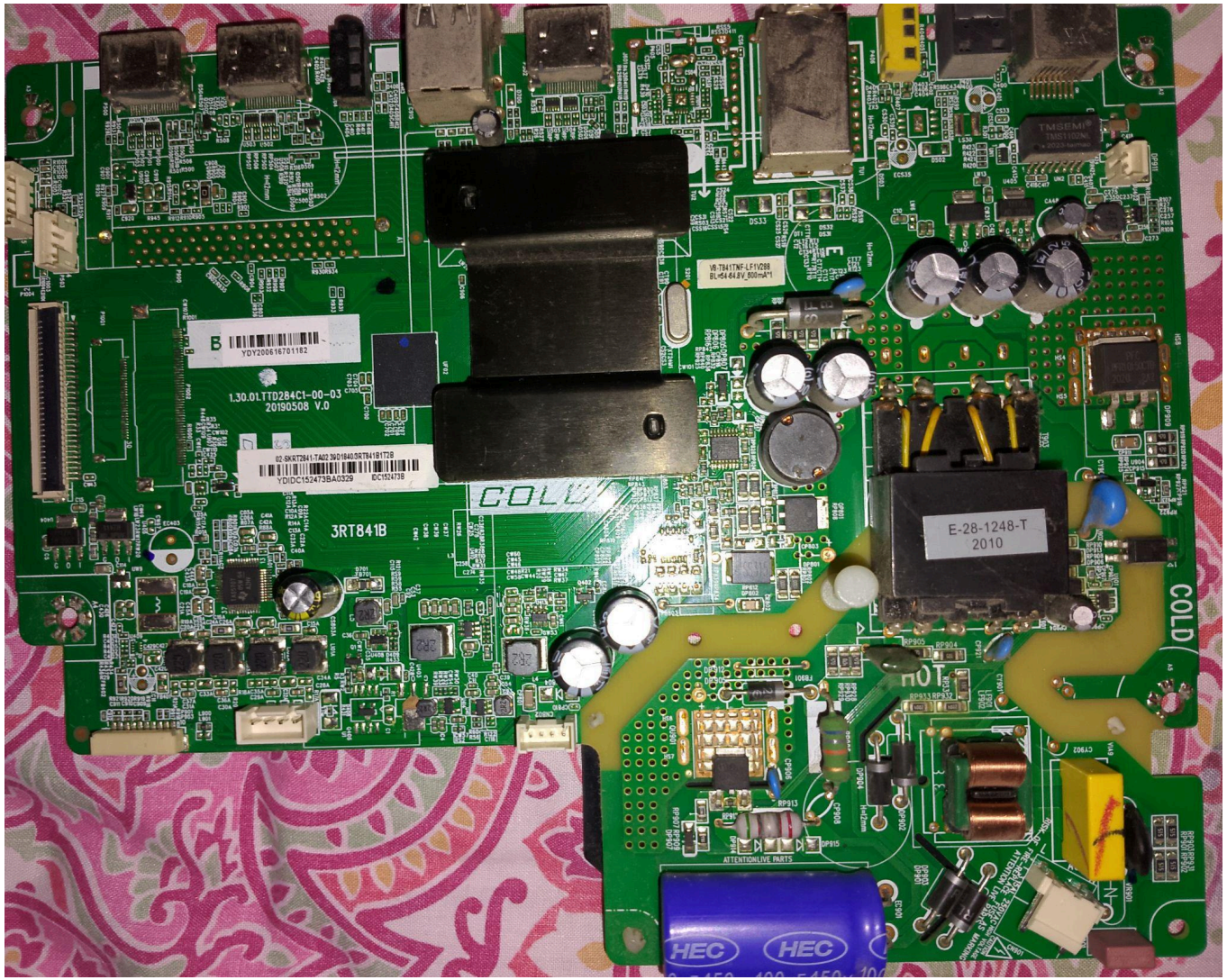
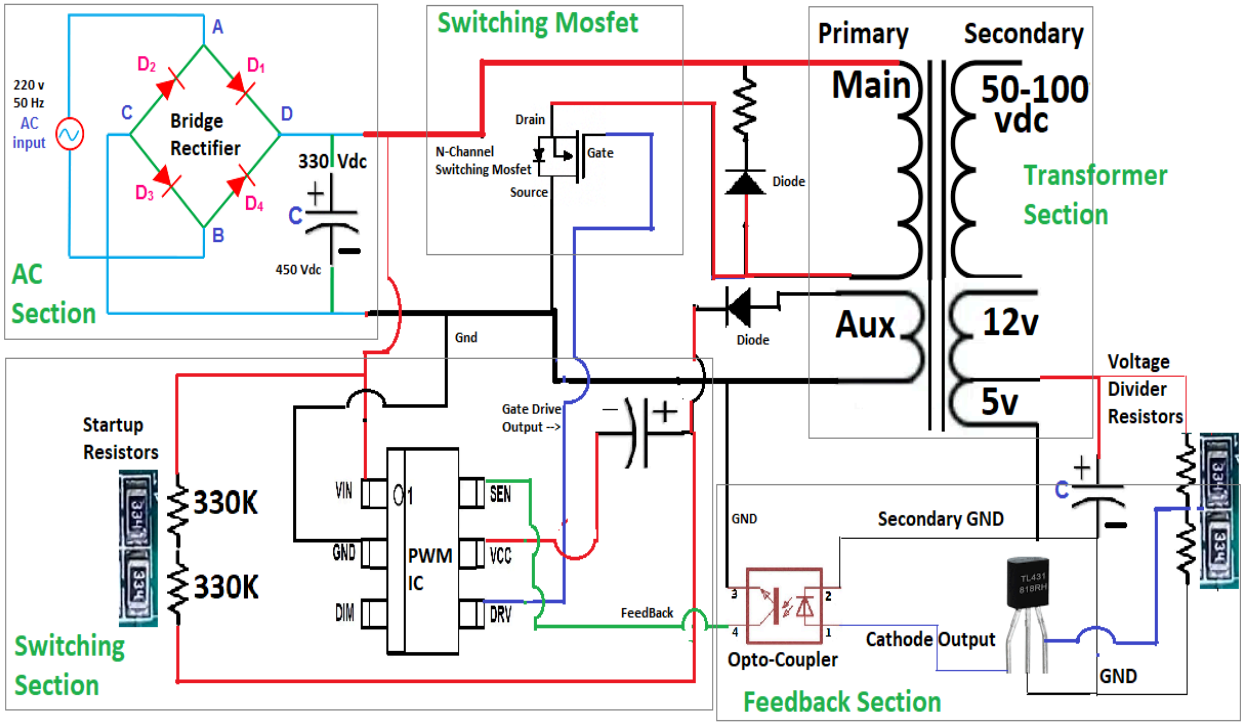
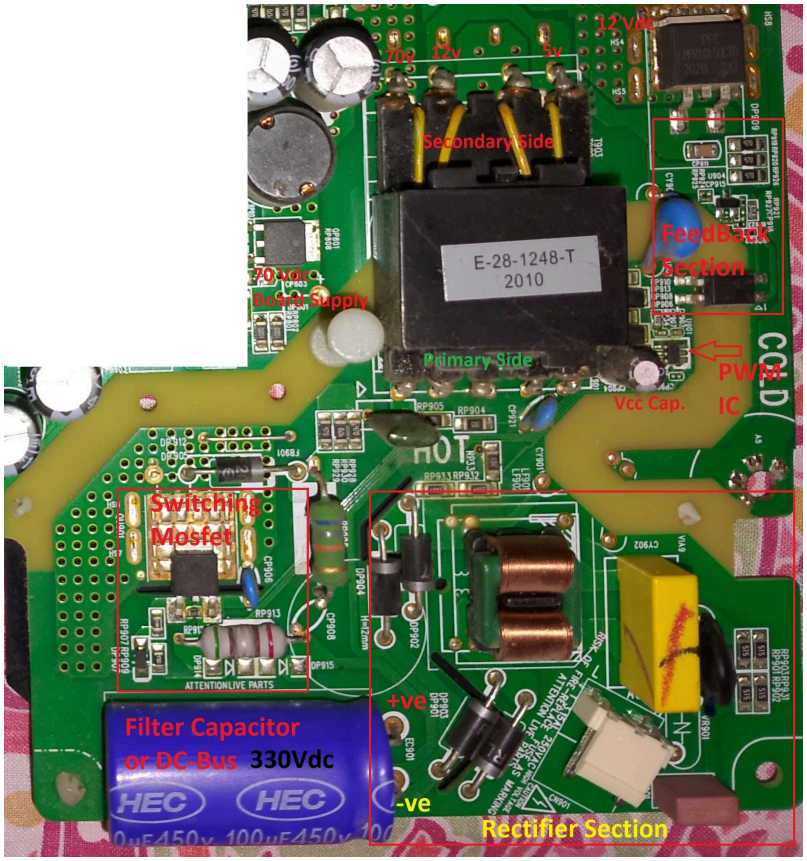
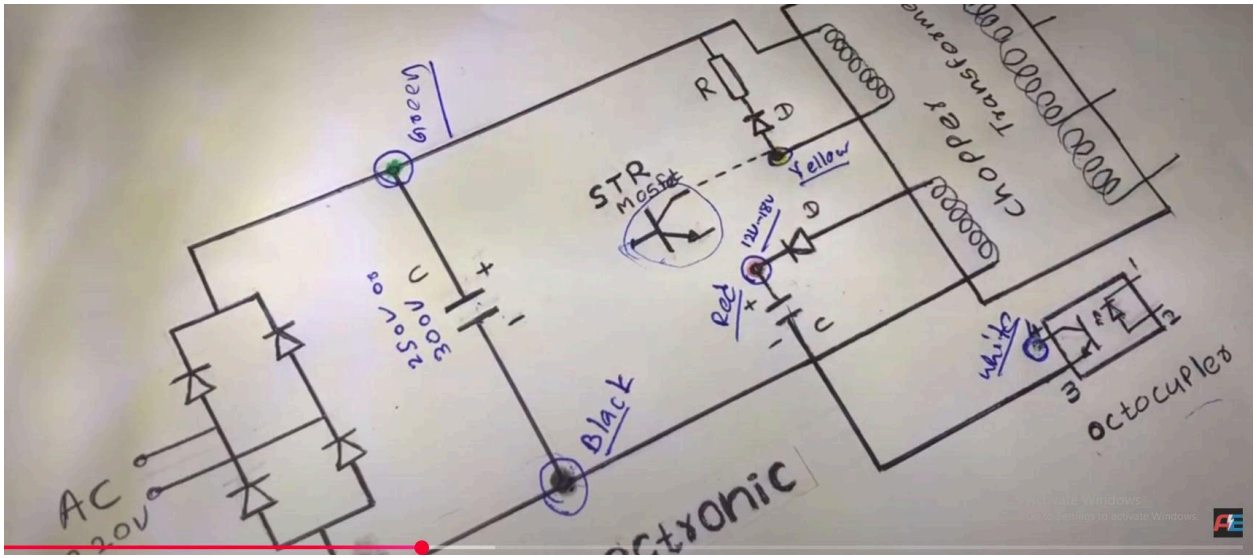
Sections / Blocks

🔵 **AC & Rectifier** → bottom-right to bottom-left (fuse → bridge → bulk cap).
🟢 **Switch section** → lower left (MOSFET, gate R, sense R, PWM IC).
🟡 **Transformer** → center.
🟣 **Aux VCC** → small diode + 47 µF cap, primary side right of transformer.
🔴 **Feedback** → yellow optocoupler + TL431 + resistors, top-right area near secondary.
🟠 **Secondary outputs** → top edge (diodes, coils, caps).









Simple Diagram

Wiring Diagrams

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🔷 Block-by-block explanation on your board

1. AC IN & Bridge section (far bottom-right → bottom-left)

- **Fuse** → bottom-right white box.
- **Black thermistor (inrush limiter)** → right beside fuse.
- **Bridge rectifier diodes (4 black diodes in a square)** → center-bottom.
- **Big blue bulk capacitor (310 V)** → bottom-left.
  👉 These make the high-voltage DC bus (~310 V).

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2. Switch section (bottom-left / lower middle)

- **MOSFET 70S360P7** → metal tab device on heatsink, left side.
- **Gate resistor** → small resistor right at MOSFET gate leg, marked in your pic.
- **Current sense resistor** → white cement-type resistor just below MOSFET source pad (low-ohm, connects source to main −).
- **PWM IC** (6-pin chip) → right of MOSFET, near yellow optocoupler.
  👉 This is the high-frequency switching stage.

3. Transformer (middle of board)

- **Big black/yellow E-28 core** → center.
- **Primary side windings** → bottom two pins (marked main winding and aux in your pic).
- **Secondary windings** → top four pins going toward cold side (5 V, 12 V, LED rails).
  👉 Isolates mains and transfers energy.

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4. Opto Feedback (upper-right of transformer)

- **Optocoupler** → small 4-pin IC in yellow case.
- **Resistor divider & TL431** (on cold side, near secondary capacitors). These sense 5 V rail and drive opto LED.
  👉 TL431 sinks current if 5 V too high → LED inside opto brightens → PWM FB pin pulled → reduces duty.

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5. Aux VCC supply (primary side, right of transformer)

- **Aux winding pin from transformer → diode → small electrolytic cap (47 µF / 50 V)**.
- That's the **VCC capacitor** that feeds PWM IC after startup.
- Before aux winding takes over, **startup resistor** (on primary side, high-value, ~100k–330k) feeds this VCC cap from 310 V bus.
  👉 This is what keeps the PWM IC alive.

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6. Secondary outputs (top side, "cold" area)

- **Rectifier diodes on heatsinks** (top-right).
  - One diode + coil + cap = 12 V.
  - One Schottky diode + coil + cap = 5 V.
  - One fast diode = LED backlight high voltage.
- **Inductors and electrolytic caps** filter each rail.
  👉 This is what actually powers the TV

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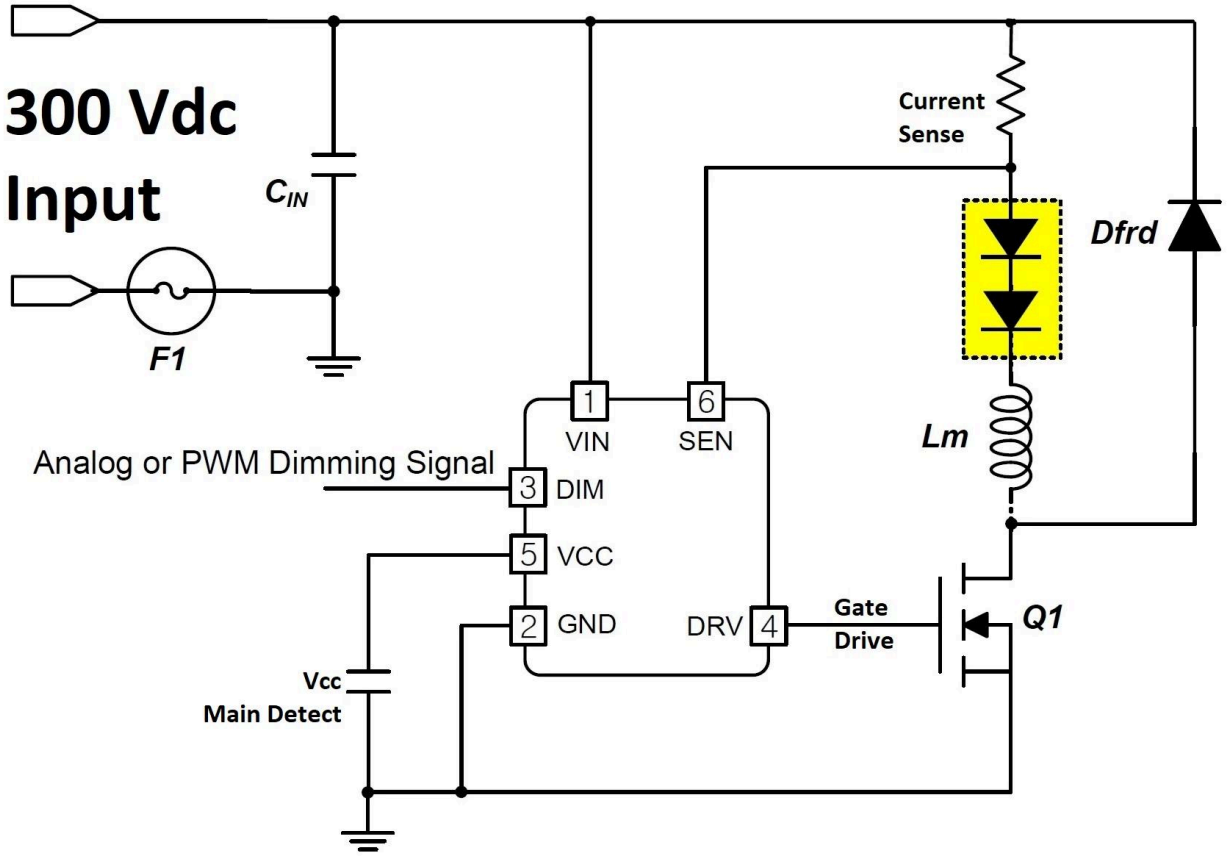
Key Components

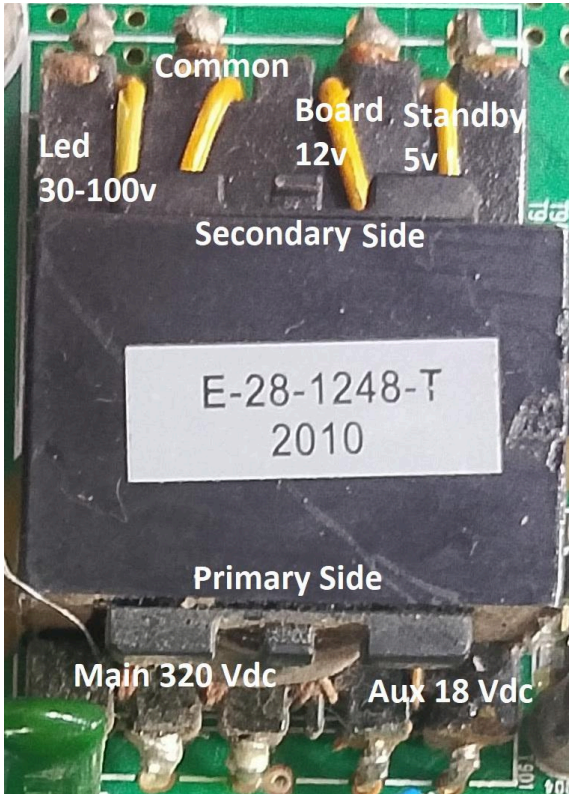
PWM IC



- **Pin 1: Protection of Main Detect VIN**
- **Pin 2: GND** (connects to source/return).
- **Pin 3: FB (Feedback)** — connected to optocoupler output.
- **Pin 4: OUT (Gate)** — drives MOSFET gate (this is the pin you already found).
- **Pin 5: Vcc (Startup supply) — 14 - 18 Vdc Startup Supply**
- **Pin 6: CS (Current Sense)** — connected to source resistor of MOSFET.

Note : Pins Arrangement may varry

Transformer



Primary side windings (4 wires)

Usually you'll see **5 pins/wires on the primary** side of the SMPS transformer:

1. **Main Primary (Drain winding)**
    - One end goes to the **MOSFET Drain (STR module's Drain wire)**.
    - The other end goes to **+310 V (main capacitor positive)**.
    - This is the high-voltage winding that actually stores energy during the MOSFET on-time.
2. **Auxiliary / Startup winding (sometimes 2 wires, sometimes tapped)**
    - Small number of turns.
    - Provides ~12–18 V DC after rectification.
    - Feeds the **VCC of the PWM IC (or STR module red wire)**.
    - Also sometimes provides bias supply for startups.

So: **out of those 4 pins** → 2 go to the main primary, 2 go to the auxiliary winding

Secondary side windings

On the **secondary** (low-voltage) side, the transformer will have **multiple separate windings**, each with 2 wires. Common sets are:

1. **5 V Standby winding**
    - Rectified by a Schottky diode + small filter capacitor.
    - Powers the TV's logic when "off" but still plugged in.
2. **12 V / 24 V main winding**
    - Rectified by larger Schottky diodes + bigger capacitors.
    - Feeds the main board, audio, and LED driver circuits.
3. **LED backlight winding (30–100 V depending on design)**
    - Higher-voltage winding.
    - Goes to LED driver IC or LED boost stage.
4. **Sometimes an extra 3.3 V or 1.8 V winding**
    - Rare; usually generated on the main board via DC-DC converters.

Each of these windings is **isolated** from the primary for safety, and each secondary winding has:

- **Rectifier diode(s)** (fast recovery or Schottky).
- **Filter capacitor** (low-ESR).
- **Sometimes an inductor** (for Pi filter).

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Startup Sequence

TV SMPS Mode Diagram (Step-by-step)

Stage 1 — Startup (cold power-on)

- **AC → Bridge → Bulk Capacitor (~310 VDC)**.
- **Startup resistor**: leaks a small current from 310 V → charges PWM IC's VCC capacitor.
- **PWM IC**: once VCC hits threshold (~12–16 V), it starts switching MOSFET.
- **At this point**: no feedback yet, open-loop pulses.

Stage 2 — Aux winding takeover

- MOSFET switching → transformer energizes.
- **Auxiliary winding** (on primary side) rectified → provides stable VCC (~12–18 V) for PWM IC.
- **Startup resistor** is now irrelevant (only used at boot).
- The SMPS can now run indefinitely because PWM VCC is self-supplied.

Stage 3 — Standby regulation (TV OFF, but plugged in)

- The transformer delivers **5 V Standby winding**.
- This 5 VSB is sensed by the resistor **divider → TL431 → optocoupler LED**.
- TL431 compares to 2.5 V reference:
    - If 5VSB high → TL431 sinks more → opto LED brightens → PWM reduces duty.
    - If 5VSB low → TL431 sinks less → opto LED dims → PWM increases duty.
- Only **5 VSB rail is regulated** here.
- Other windings (12 V, LED-HV) are inactive since PS-ON is low.

Stage 4 — Full ON regulation (TV ON with remote)

- TV mainboard asserts **PS-ON → SMPS enable**.
- PWM controller allows **higher duty cycle** → energizing all transformer windings.
- **12 V winding** → powers audio, T-con.
- **LED HV winding (24–100 V)** → powers backlight.
- Feedback is **still via TL431 + opto on 5 V**, but cross-regulation keeps other rails in proportion.

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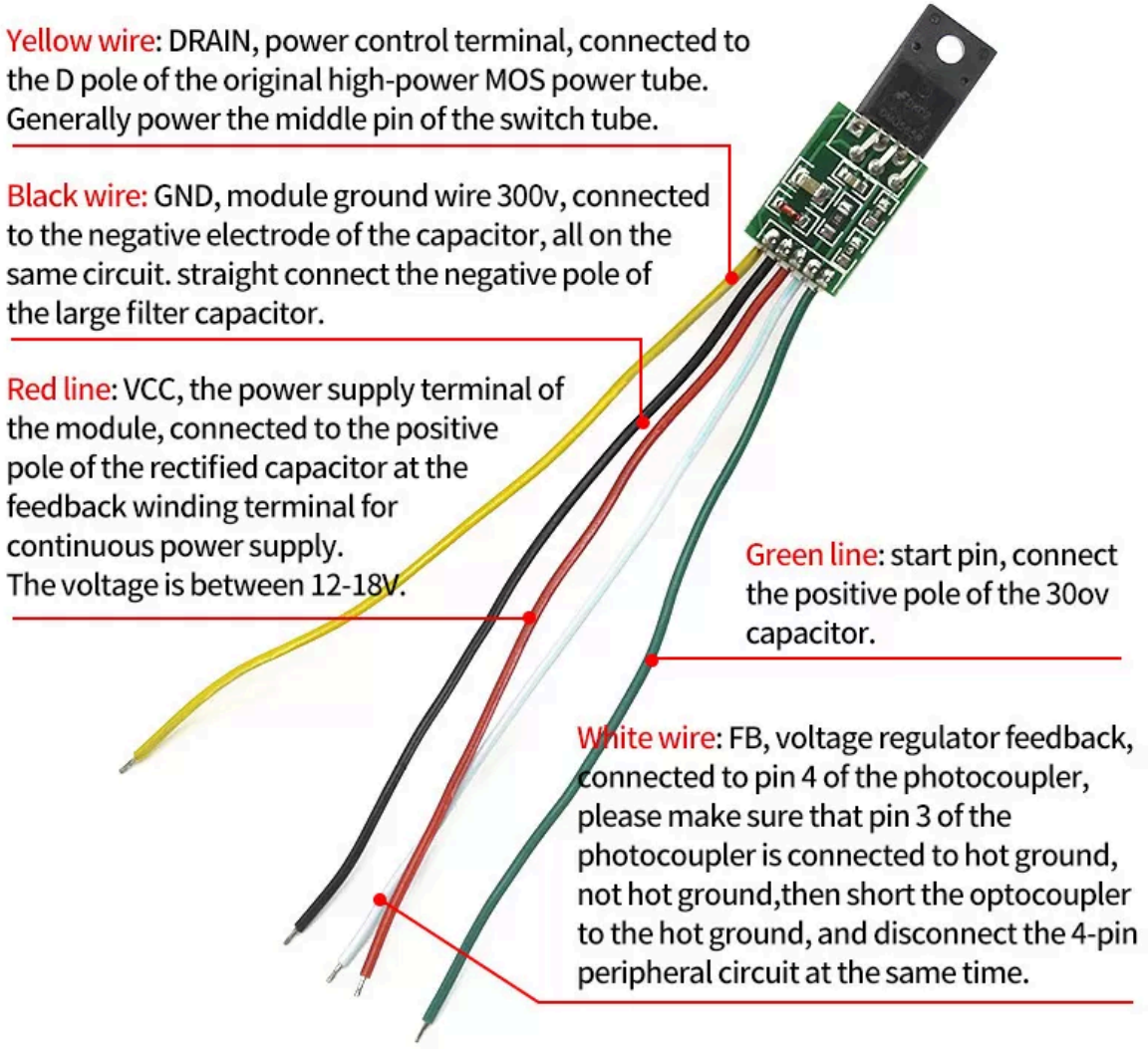
CA888 STR Pinout (5 wires)



Typical wiring is:

1. **AC+ (Vcc+)** → Connect to positive of main filter capacitor (~300V DC after rectifier).
2. **AC– (GND)** → Connect to negative of main filter capacitor.
3. **Drain** → Connect to primary winding of transformer (same point where MOSFET Drain was).

4. **FB (Feedback)** → Connect to optocoupler output (the pin that used to go to old PWM IC).

5. **Startup / Vcc** → Sometimes internally managed, but some versions need auxiliary winding from the transformer.

Note

1. You must remove the old MOSFET and PWM IC, otherwise both will fight for control.

2. Sometimes technicians also disconnect the current sense resistor because STR has its own.

3. The optocoupler + TL431 usually remains to regulate voltage.
4. 4 Wire Str Module Has only Green Wire missing,
5. 3 Wire STR has Green and Red Wires Missing, as it has its own Circuitery for ACC, Green Wire using the Yellow wire
6. All of the Above STR Modules will only work if the Opto-Feedback Section is not Faulty.

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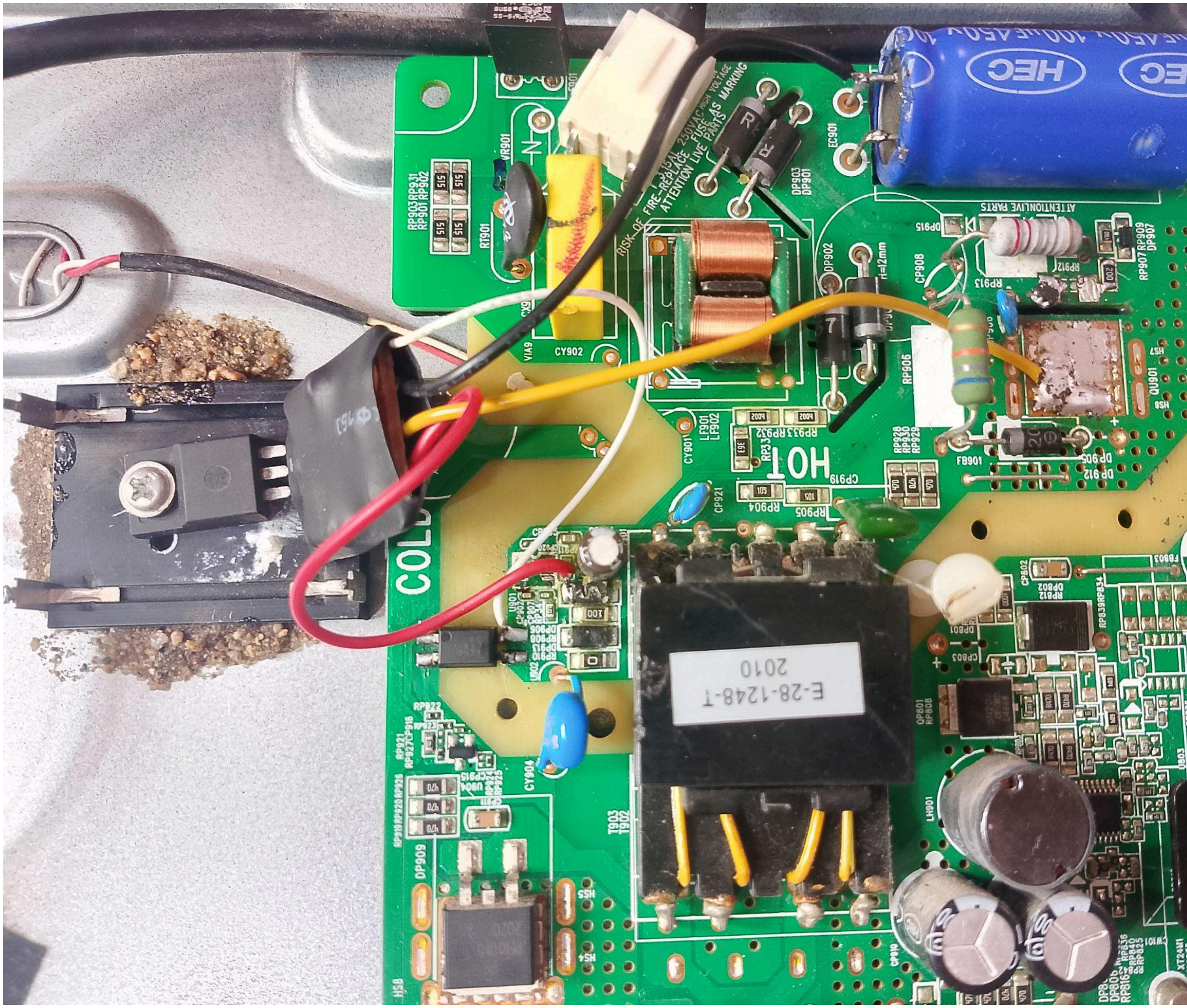
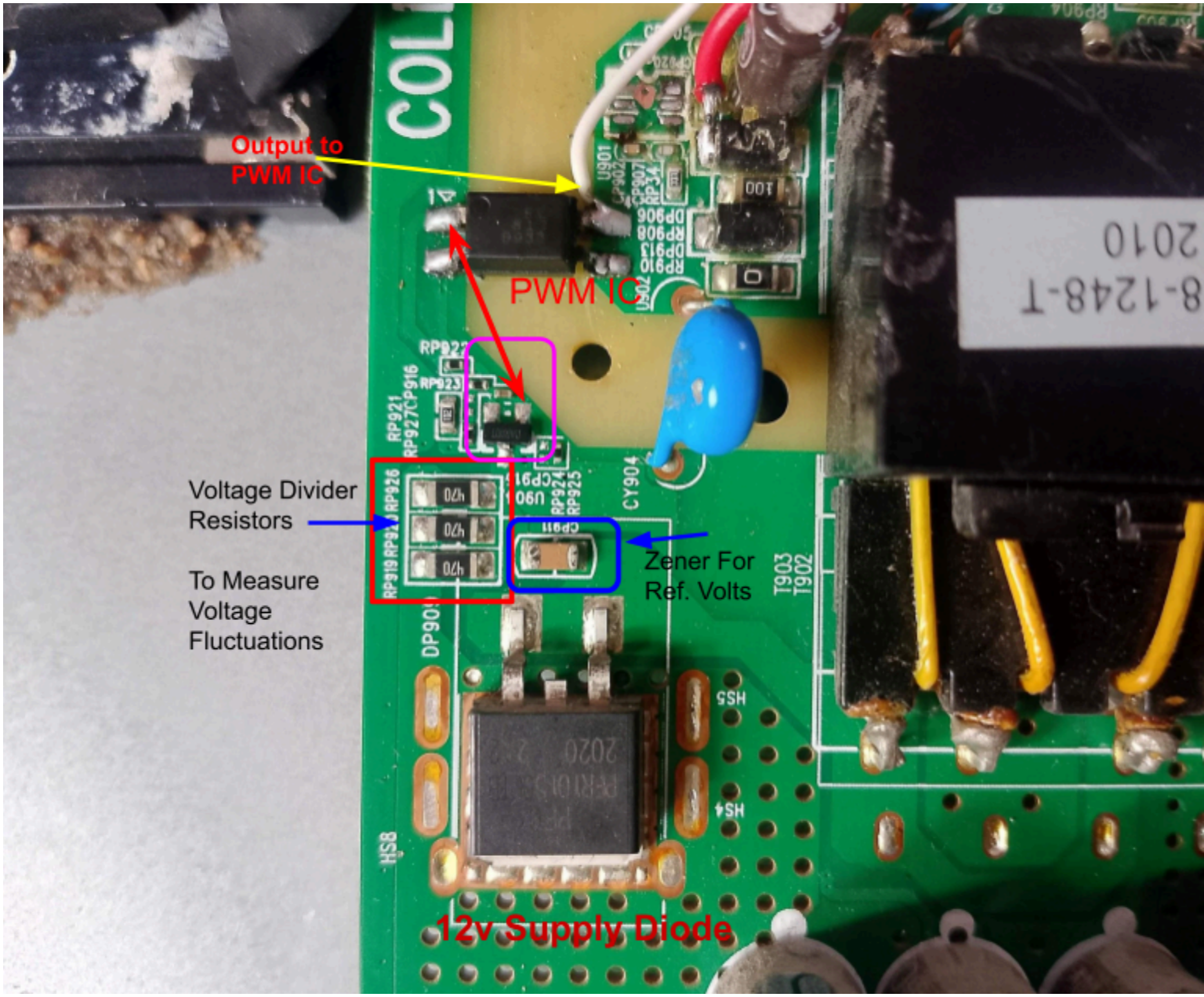
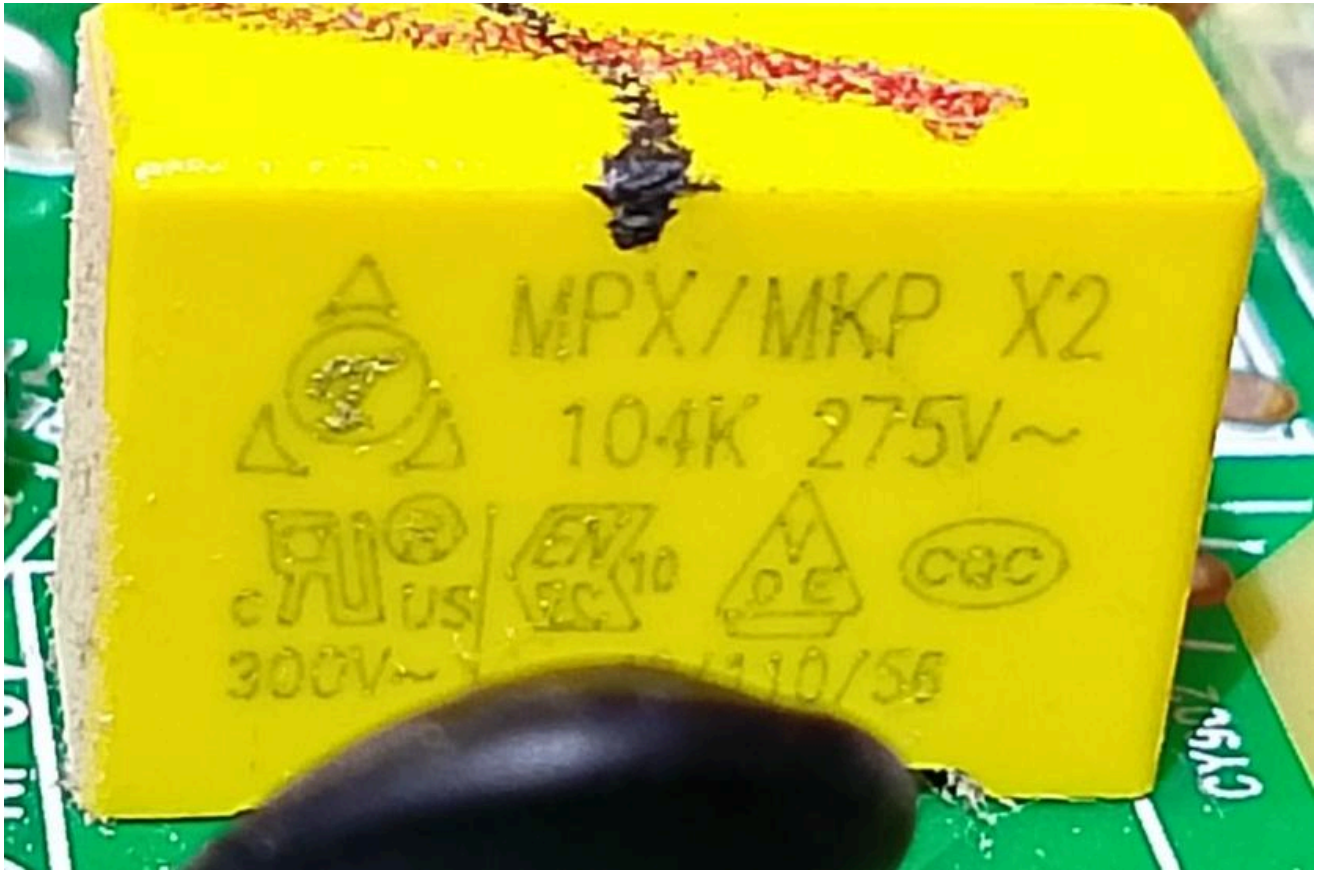
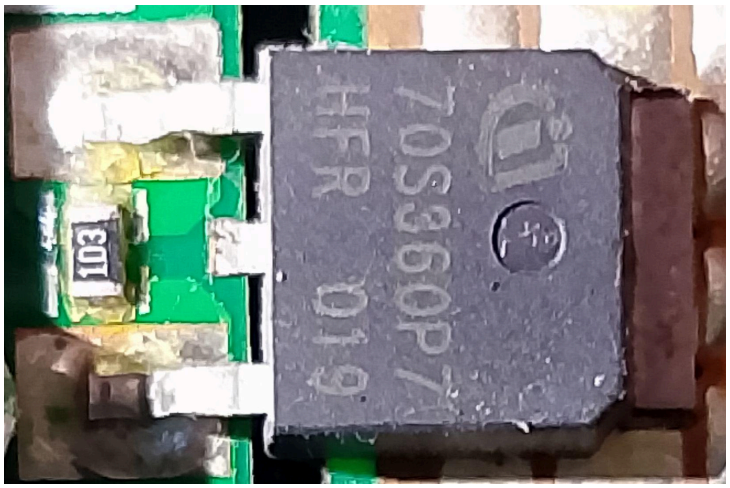
Other Images

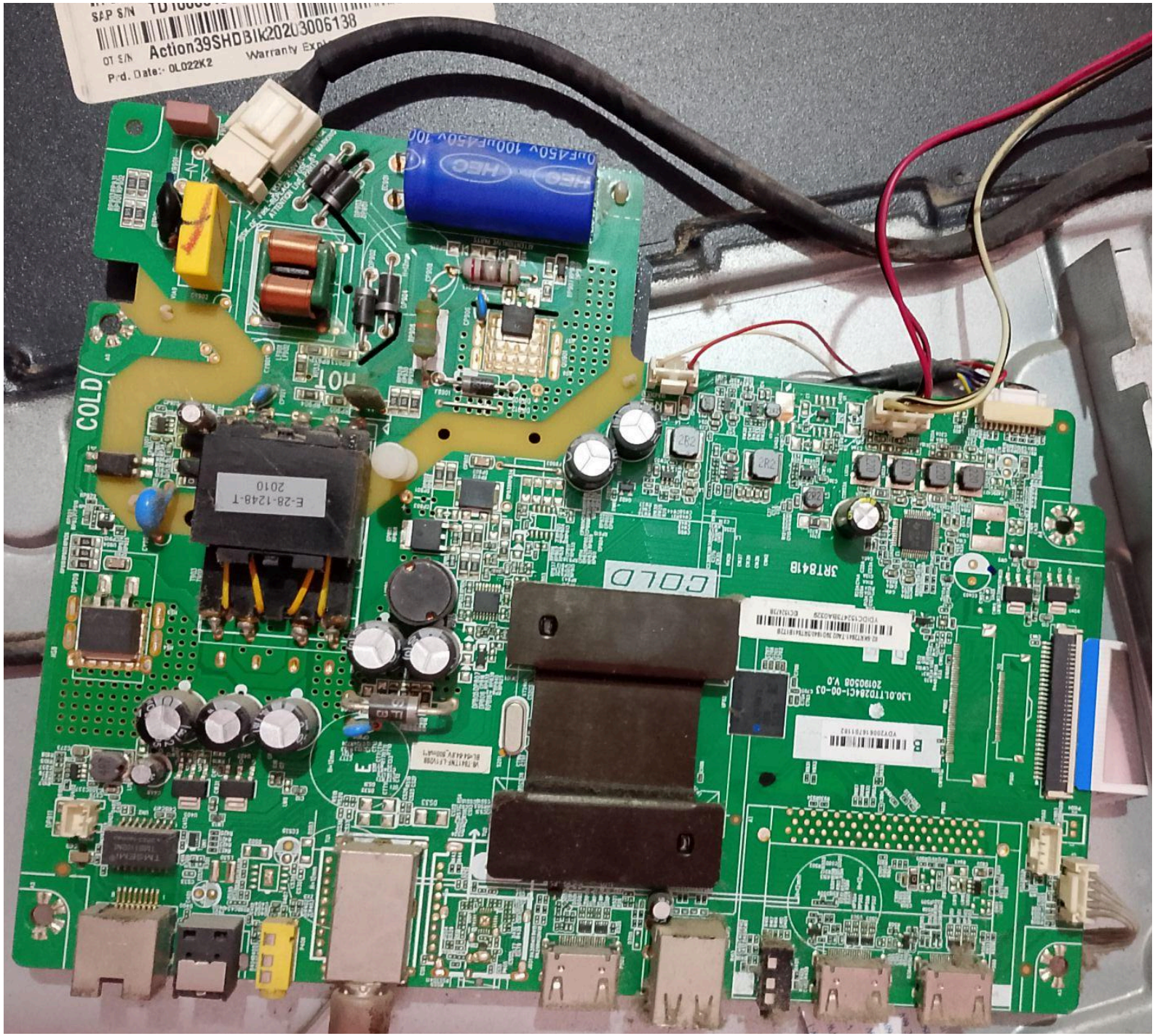



Output to
PWM IC
PWM IC
Voltage Divider
Resistors
To Measure
Voltage
Fluctuations
Zener For
Ref. Volts
12v Supply Diode





Faulty Mosfet + Thermister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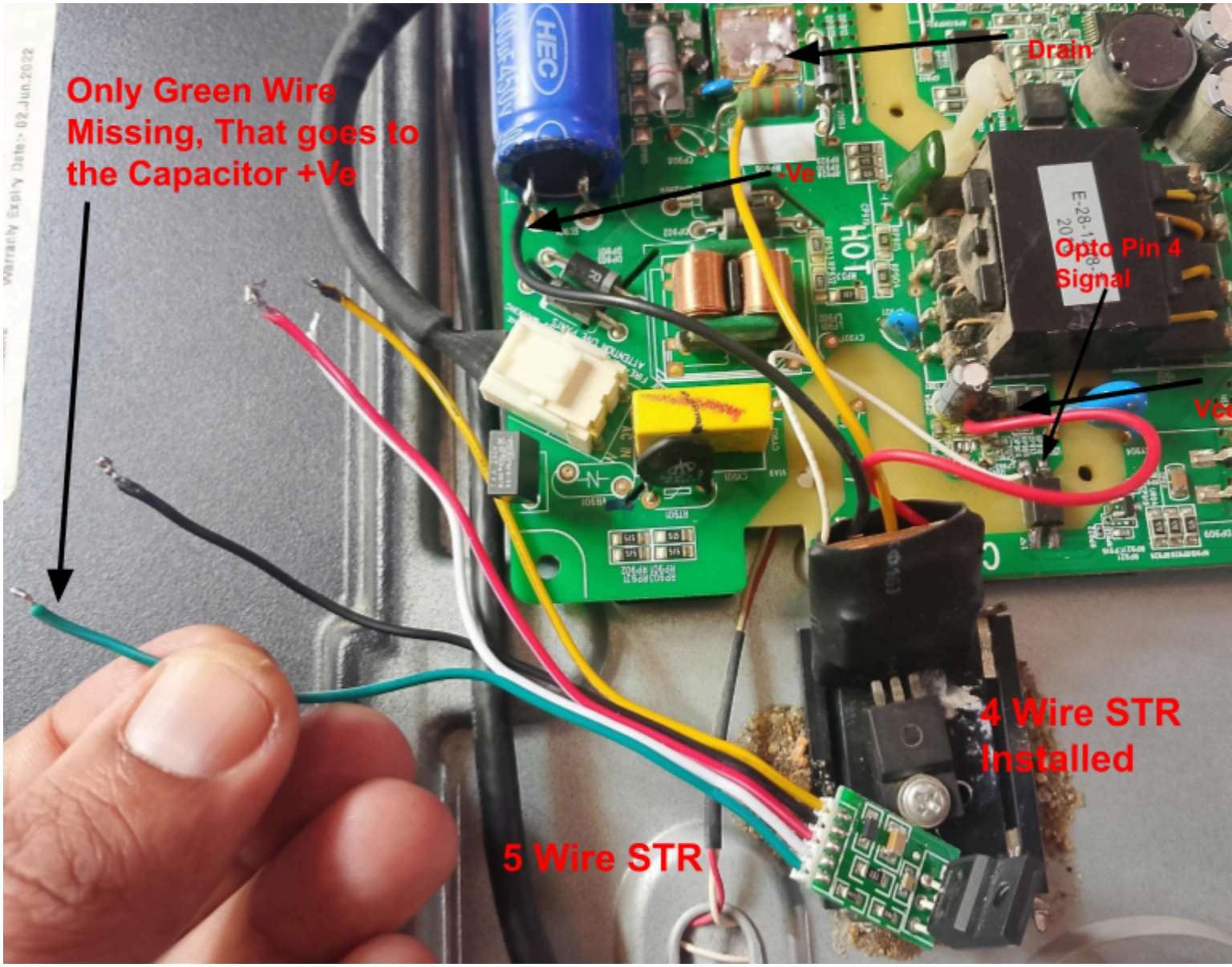
Only Green Wire
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Opto Pin 4
Signal
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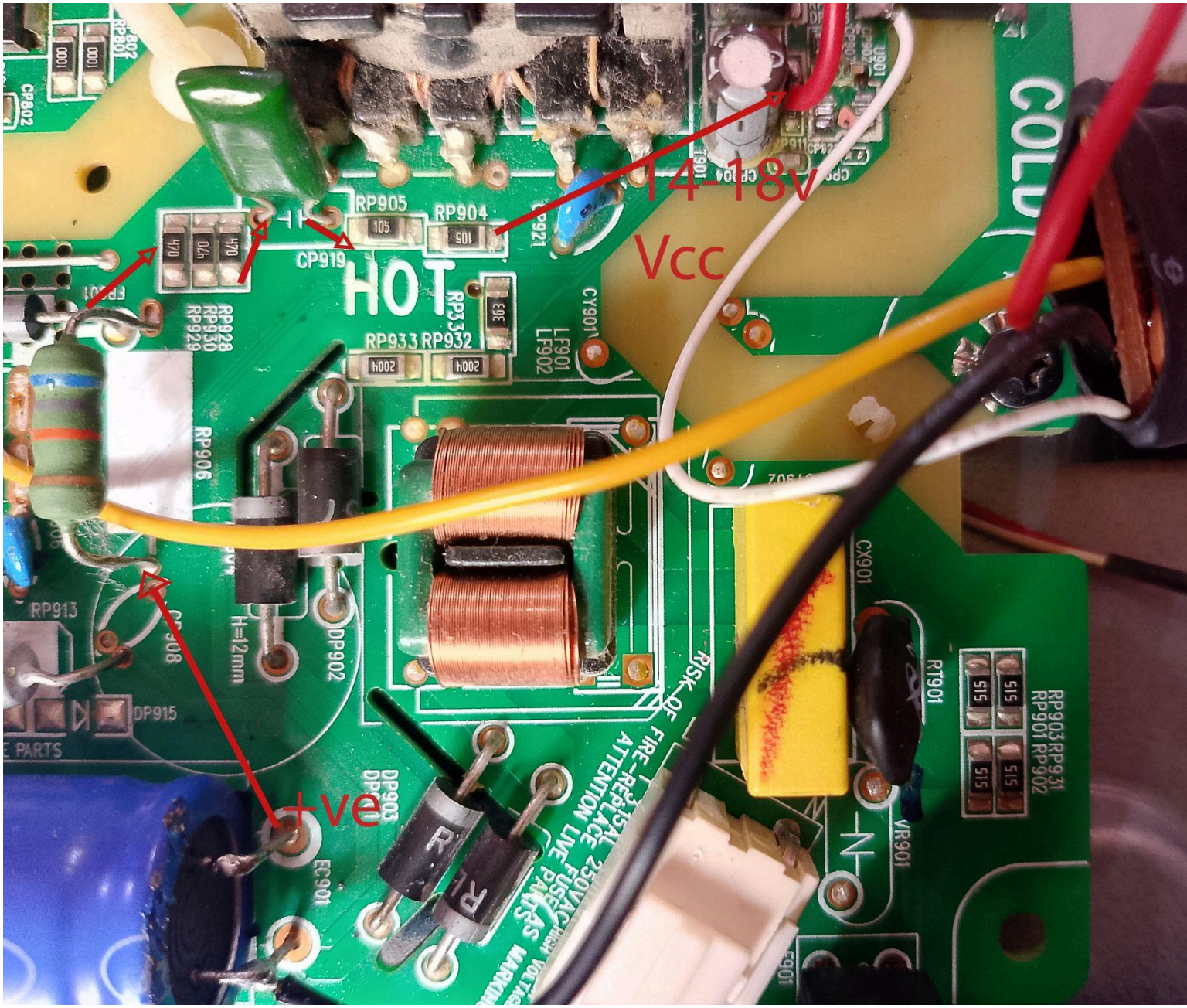
5 Wire STR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EC901
CY901
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RT901
VR901
RP903
RP931
RP901
RP902
CX901
RISK OF
FIRE-REPLACE
ATTENTION USE
PARTS