ESP32-S3 Meter Coupler - Simplified Section-by-Section Schematics

PART 1: POWER SUPPLY (Start Here!)

This is the simplest part. Just 4 steps:

Step 1: Connect Battery

Red wire (Battery +) ──► to ONE side of switch

Black wire (Battery -) ──► to GND rail

Step 2: Connect Switch

Other side of switch ──► to AMS1117 regulator VIN pin

Step 3: Connect Regulator (AMS1117-3.3)

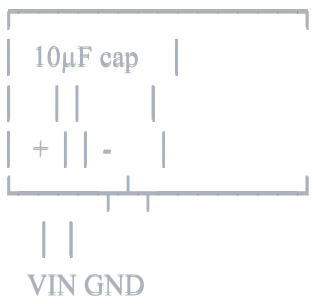
VIN (pin 1) ◄─── from switch

GND (pin 2) ──► to GND rail (black wires)

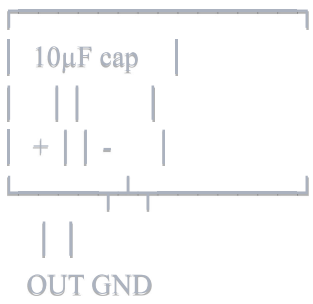
OUT (pin 3) ──► to +3.3V rail

Step 4: Add Capacitors (these keep voltage clean)

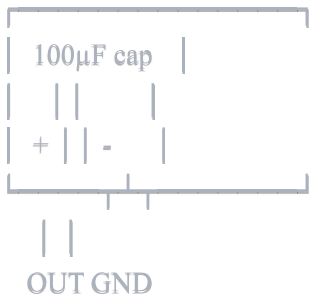
Input side (between VIN and GND):



Output side (between OUT and GND):



Big cap on output (bulk filtering):



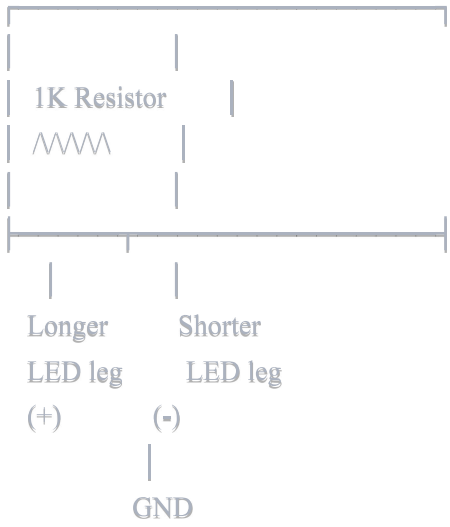
RESULT: You now have clean 3.3V power for everything!

PART 2: LED INDICATORS (Very Simple!)

There are 3 LEDs. Each one is identical:

LED #1: GREEN (Power On Indicator)

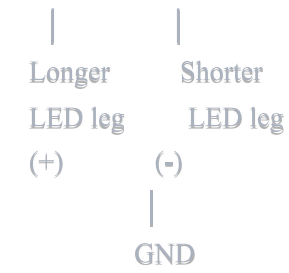
From ESP32 GPIO21:



That's it! When GPIO21 goes HIGH, LED lights up.

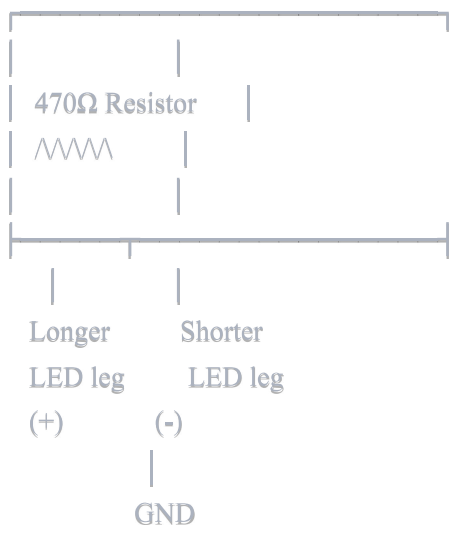
LED #2: YELLOW (RX Activity)

From ESP32 GPIO8:



LED #3: RED (TX Activity)

From ESP32 GPIO9:



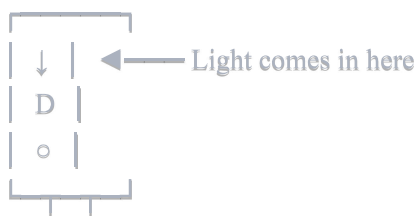
IMPORTANT:
- Long leg of LED = positive (+) goes to resistor
- Short leg of LED = negative (-) goes to GND
- If LED doesn't light, flip it around

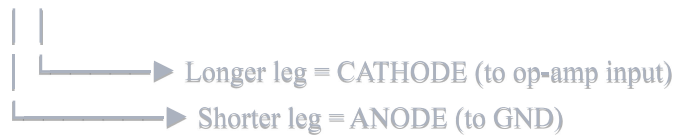
PART 3: IR RECEIVER (Photodiode → Meter Data)

PURPOSE: Read infrared signals FROM the meter

STEP 1: Connect Photodiode (WP3DP3BT/BD)

Point this at the meter's IR window:

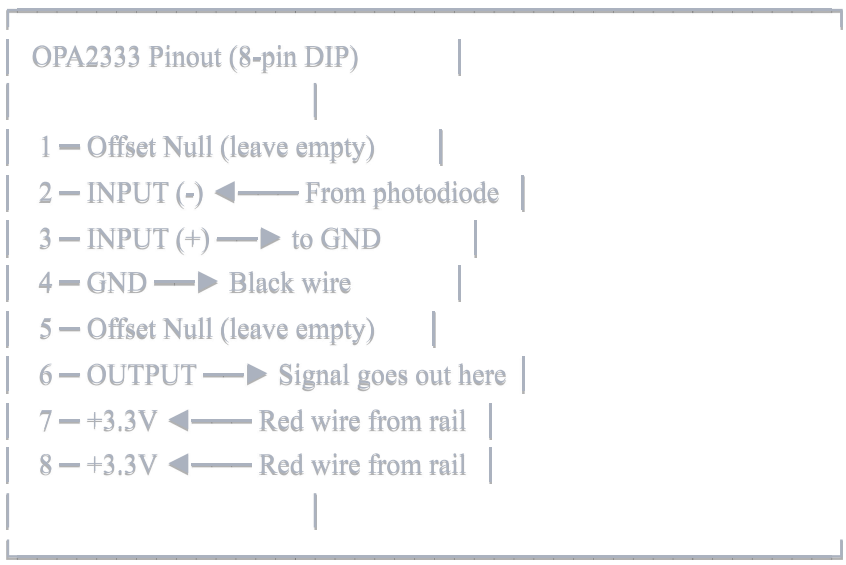




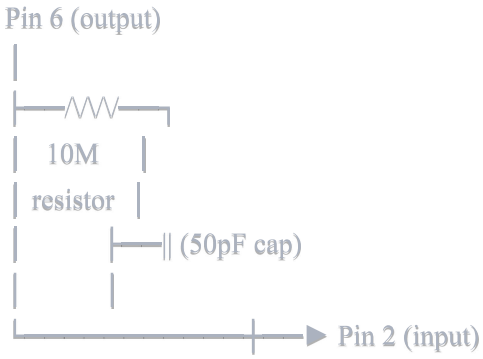
STEP 2: Connect to Op-Amp (OPA2333 - This amplifies tiny signals)

The photodiode puts out TINY currents (picoamps).
The op-amp converts this to readable voltage.

Photodiode cathode (longer leg)



Add 10M resistor + 50pF cap around pins 2 and 6:
(This is the "feedback network" - it sets the gain)



STEP 3: Clean up the signal (Schmitt Trigger)

Use the SECOND half of the same OPA2333:

From first op-amp pin 6 (output)

```
└──► Pin 10 (inverting input)
```

```
┌──────────────────────────────────────────┐
│ OPA2333 Pinout (SECOND OP-AMP)           │
│                                          │
│  9 ─ Offset Null (leave empty)           │
│ 10 ─ INPUT (-) ◄──── From op-amp 1       │
│ 11 ─ INPUT (+) ──► to GND                │
│ 12 ─ GND ──► Black wire                  │
│ 13 ─ Offset Null (leave empty)           │
│ 14 ─ OUTPUT ──► Clean signal out         │
│ 15 ─ +3.3V ◄──── Red wire                │
│ 16 ─ +3.3V ◄──── Red wire                │
│                                          │
└──────────────────────────────────────────┘
```

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Pin 14 output ──► ESP32 GPIO44 (UART RX input)
```

SUMMARY OF RECEIVER:

```
Meter (IR) ──► Photodiode ──► Op-amp 1 ──► Op-amp 2 ──► ESP32 GPIO44
```

PART 4: IR TRANSMITTER (Send Signals TO Meter)

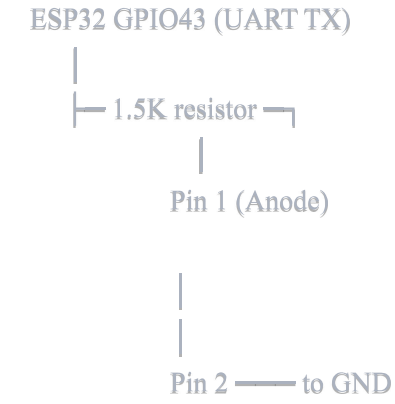
PURPOSE: Send infrared signals TO the meter

STEP 1: Connect Optocoupler (TLP291)

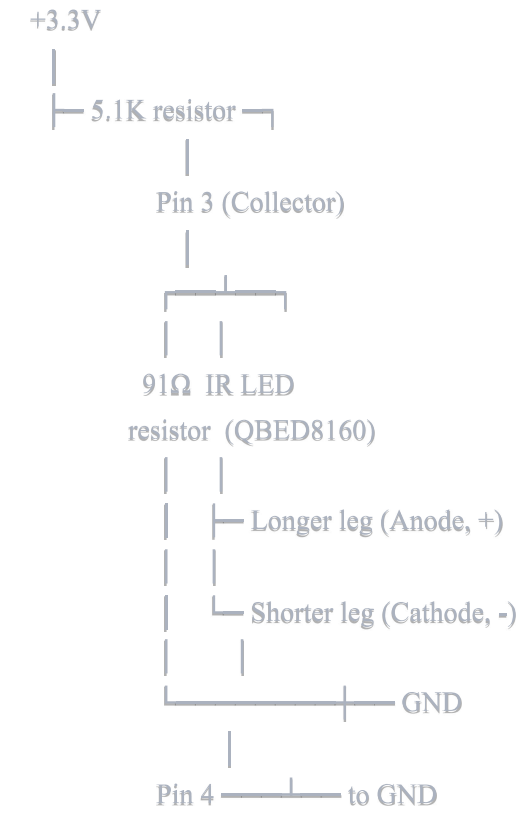
This device isolates ESP32 from meter interference.

```
┌──────────────────────────────────┐
│ TLP291 Optocoupler (DIP-4)       │
│                                  │
│ Pin 1: LED Anode (+)             │
│ Pin 2: LED Cathode (-)           │
│ Pin 3: Phototransistor Output    │
│ Pin 4: Phototransistor Emitter   │
│                                  │
└──────────────────────────────────┘
```

STEP 2: Drive the Optocoupler LED



STEP 3: Optocoupler Output drives IR LED



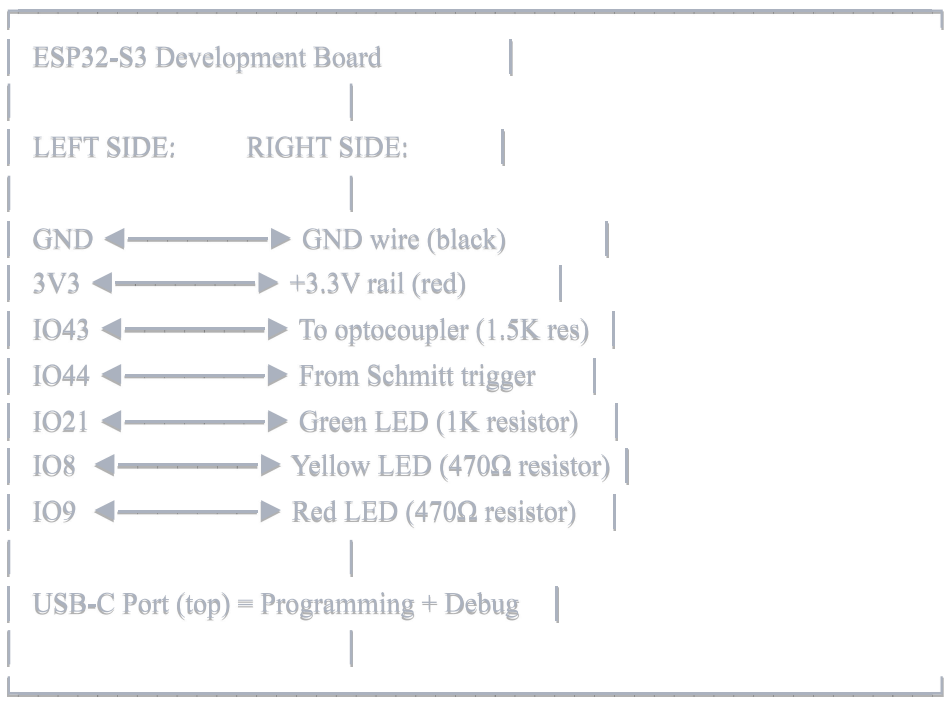
STEP 4: Connections Summary

ESP32 GPIO43 ⟶ 1.5K resistor ⟶ TLP291 Pin 1
TLP291 Pin 2 ⟶ GND
+3.3V ⟶ 5.1K resistor ⟶ TLP291 Pin 3
TLP291 Pin 3 ⟶ 91Ω resistor ⟶ IR LED (+)
IR LED (-) ⟶ GND
TLP291 Pin 4 ⟶ GND

SUMMARY OF TRANSMITTER:
ESP32 GPIO43 ⟶ Optocoupler ⟶ IR LED ⟶ Meter (IR Window)

PART 5: ESP32-S3 BOARD CONNECTIONS

The ESP32-S3 is your brain. Here's what connects where:



That's it! Only 8 connections to make:

1. GND
2. 3V3 (+3.3V)
3. GPIO43 (to optocoupler)
4. GPIO44 (from receiver)
5. GPIO21 (green LED)
6. GPIO8 (yellow LED)
7. GPIO9 (red LED)
8. USB-C (for loading code)

COMPLETE WIRING CHECKLIST

Power System:

- ☐ Battery red wire → one side of switch
- ☐ Battery black wire → GND rail
- ☐ Switch other side → AMS1117 VIN
- ☐ AMS1117 GND → GND rail
- ☐ AMS1117 OUT → +3.3V rail

☐ 10µF cap on VIN side (+ to VIN, - to GND)
☐ 10µF cap on OUT side (+ to OUT, - to GND)
☐ 100µF cap on OUT side (+ to OUT, - to GND)

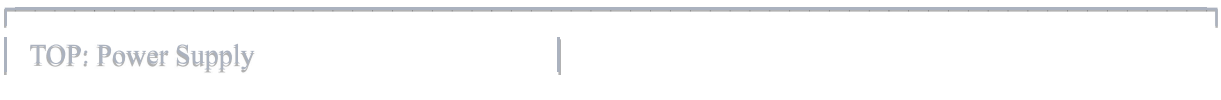
LEDs:
☐ Green LED: GPIO21 ─ 1K resistor ─ LED+ (long leg)
☐ Green LED: LED- (short leg) ─ GND
☐ Yellow LED: GPIO8 ─ 470Ω resistor ─ LED+ (long leg)
☐ Yellow LED: LED- (short leg) ─ GND
☐ Red LED: GPIO9 ─ 470Ω resistor ─ LED+ (long leg)
☐ Red LED: LED- (short leg) ─ GND

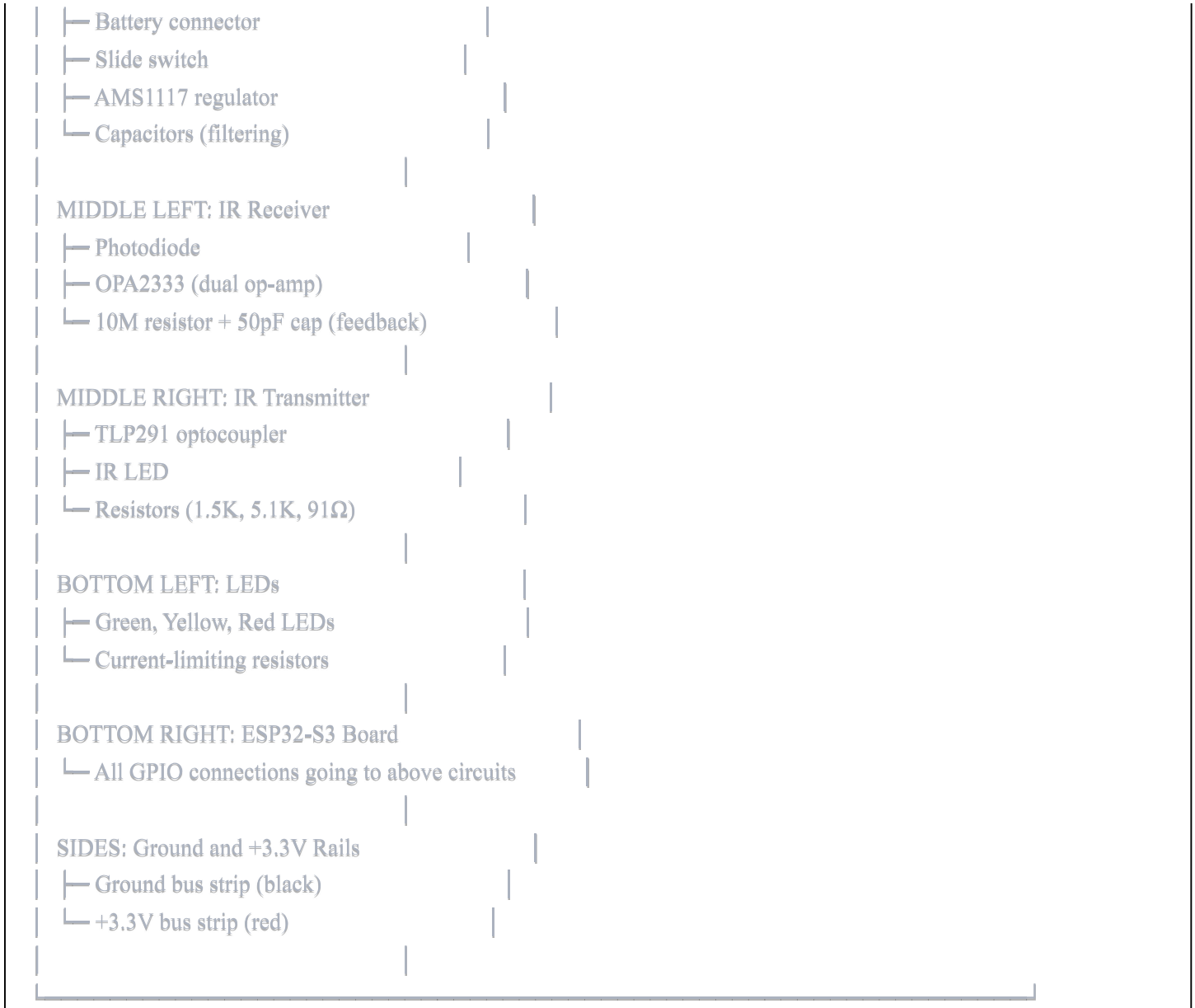
IR Receiver:
☐ Photodiode cathode (long leg) → OPA2333 pin 2
☐ Photodiode anode (short leg) → GND
☐ 10M resistor: pin 6 to pin 2 (feedback)
☐ 50pF cap: parallel with 10M resistor
☐ OPA2333 pins 2,3,4,7,8 wired as shown
☐ Second OPA2333 stage: pin 14 → GPIO44

IR Transmitter:
☐ GPIO43 ─ 1.5K resistor ─ TLP291 pin 1
☐ TLP291 pin 2 ─ GND
☐ +3.3V ─ 5.1K resistor ─ TLP291 pin 3
☐ TLP291 pin 3 ─ 91Ω resistor ─ IR LED +
☐ IR LED - ─ GND
☐ TLP291 pin 4 ─ GND

ESP32-S3:
☐ GND to GND rail
☐ 3V3 to +3.3V rail
☐ GPIO43 to transmitter
☐ GPIO44 to receiver
☐ GPIO21 to green LED
☐ GPIO8 to yellow LED
☐ GPIO9 to red LED

Quick Reference: Part Locations on Breadboard





Pro Tips for Building

1. **Start with power first -** Get 3.3V working before adding anything else
2. **Test LEDs early -** They tell you if GPIO is working
3. **Use different colored wires -** Red for +3.3V, Black for GND, Green for signals
4. **Keep short wires -** Long wires pick up noise
5. **Multimeter is your friend -** Test every voltage and connection
6. **Take photos -** Document what you build in case you need to troubleshoot

Good luck! Which part would you like me to clarify further?