

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)

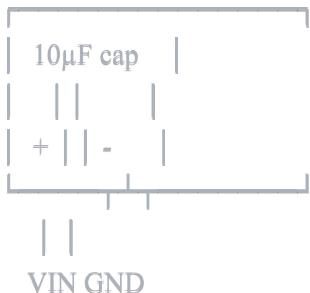
VIN (pin 1) ←—— from switch

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

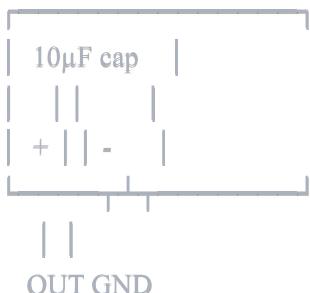
OUT (pin 3) —► to +3.3V rail

Step 4: Add Capacitors (these keep voltage clean)

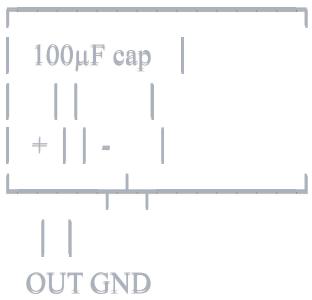
Input side (between VIN and GND):



Output side (between OUT and GND):



Big cap on output (bulk filtering):



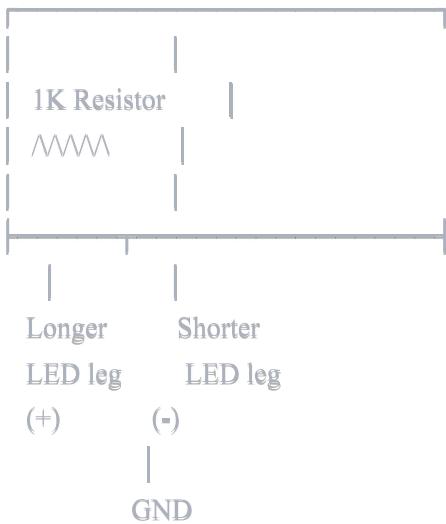
RESULT: You now have clean 3.3V power for everything!

PART 2: LED INDICATORS (Very Simple!)

There are 3 LEDs. Each one is identical:

LED #1: GREEN (Power On Indicator)

From ESP32 GPIO21:

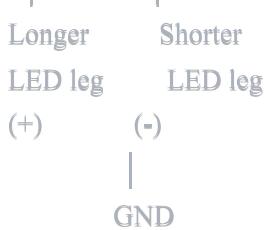


That's it! When GPIO21 goes HIGH, LED lights up.

LED #2: YELLOW (RX Activity)

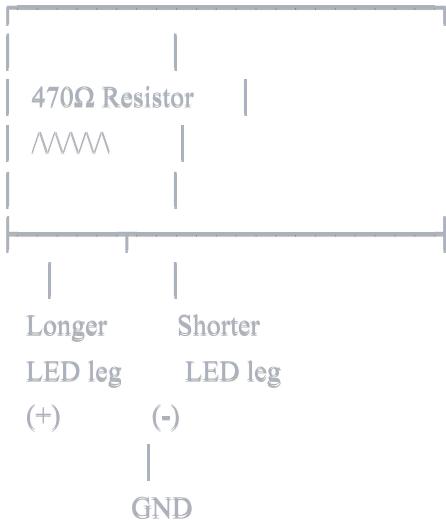
From ESP32 GPIO8:





LED #3: RED (TX Activity)

From ESP32 GPIO9:



IMPORTANT:

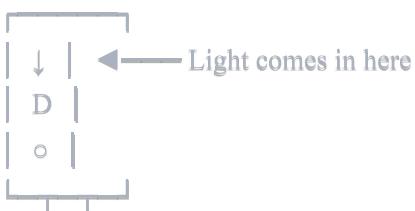
- Long leg of LED = positive (+) goes to resistor
- Short leg of LED = negative (-) goes to GND
- If LED doesn't light, flip it around

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:



- ▶ Longer leg = CATHODE (to op-amp input)
- ▶ Shorter leg = ANODE (to GND)

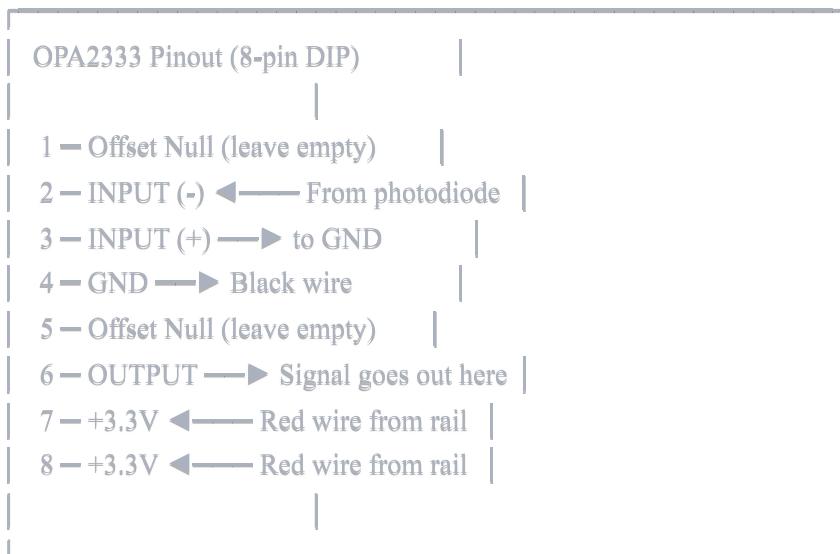
STEP 2: Connect to Op-Amp (OPA2333 - This amplifies tiny signals)

The photodiode puts out TINY currents (picoamps).

The op-amp converts this to readable voltage.

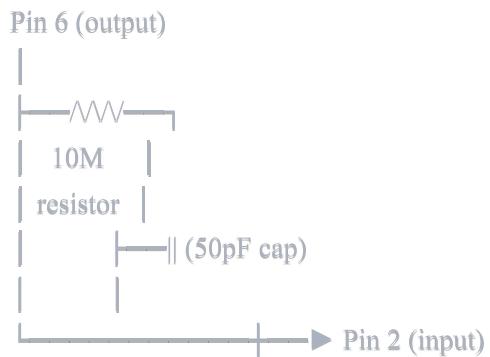
Photodiode cathode (longer leg)

- ▶ Goes to op-amp PIN 2 (inverting input)



Add 10M resistor + 50pF cap around pins 2 and 6:

(This is the "feedback network" - it sets the gain)

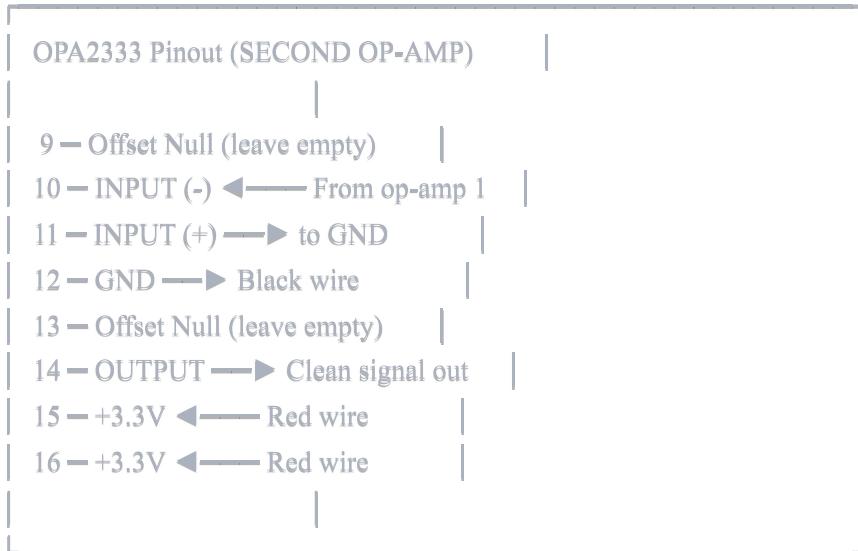


STEP 3: Clean up the signal (Schmitt Trigger)

Use the SECOND half of the same OPA2333:

From first op-amp pin 6 (output)

→ Pin 10 (inverting input)



Pin 14 output → ESP32 GPIO44 (UART RX input)

SUMMARY OF RECEIVER:

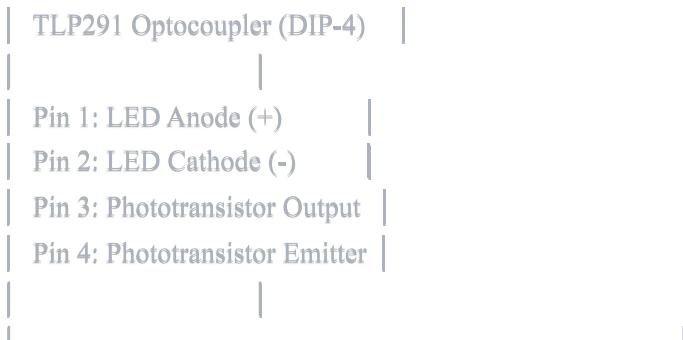
Meter (IR) → Photodiode → Op-amp 1 → Op-amp 2 → ESP32 GPIO44

PART 4: IR TRANSMITTER (Send Signals TO Meter)

PURPOSE: Send infrared signals TO the meter

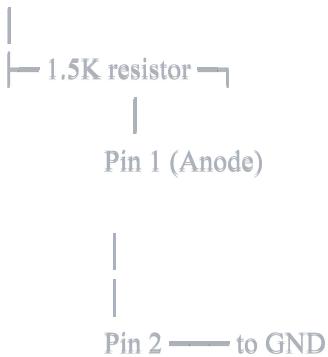
STEP 1: Connect Optocoupler (TLP291)

This device isolates ESP32 from meter interference.



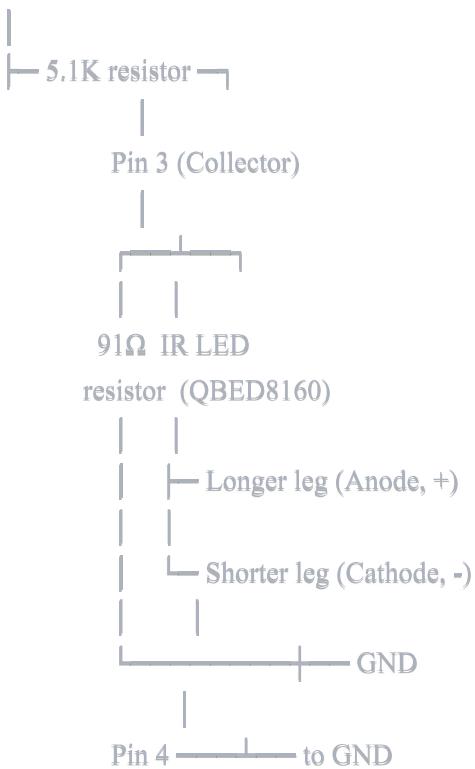
STEP 2: Drive the Optocoupler LED

ESP32 GPIO43 (UART TX)



STEP 3: Optocoupler Output drives IR LED

+3.3V



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

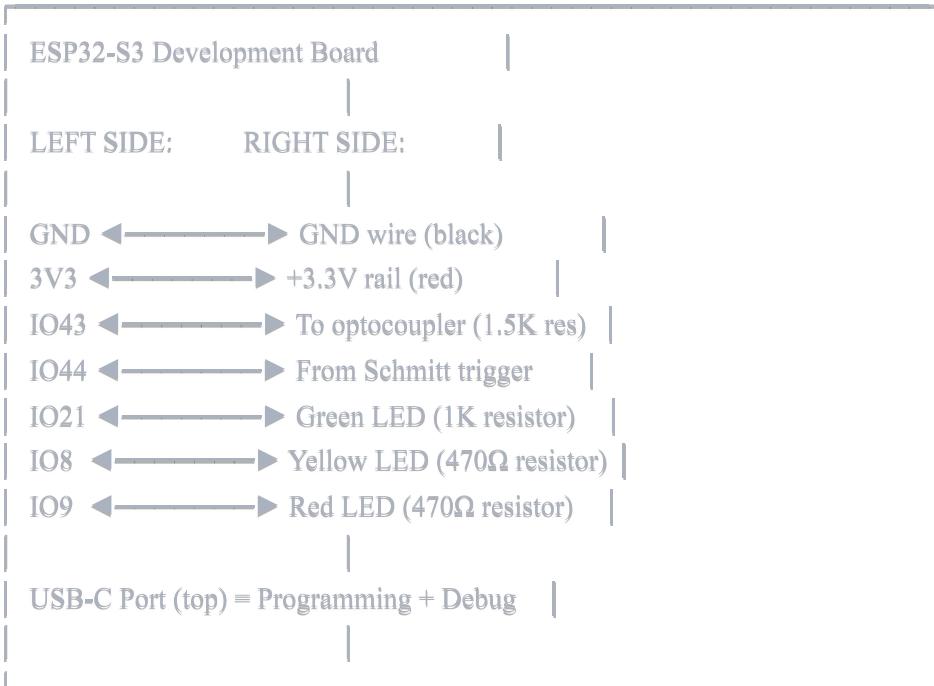
TLP291 Pin 4 → GND

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

- 10 μ F cap on VIN side (+ to VIN, - to GND)
- 10 μ F cap on OUT side (+ to OUT, - to GND)
- 100 μ F 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 — 470 Ω resistor — LED+ (long leg)
- Yellow LED: LED- (short leg) — GND
- Red LED: GPIO9 — 470 Ω 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 — 91 Ω 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

The schematic diagram illustrates the internal structure of a circuit board. It features several functional blocks connected by a central vertical bus. At the top left, there's a power section with a battery connector, slide switch, AMS1117 regulator, and capacitors for filtering. To the right of the power section is a middle-left block labeled "MIDDLE LEFT: IR Receiver", which contains a photodiode and an OPA2333 dual op-amp with a 10M resistor and 50pF cap for feedback. To the right of the receiver is a middle-right block labeled "MIDDLE RIGHT: IR Transmitter", which includes a TLP291 optocoupler, an IR LED, and resistors of 1.5K, 5.1K, and 91Ω. Below these are two bottom-left blocks labeled "BOTTOM LEFT: LEDs", each containing green, yellow, and red LEDs along with current-limiting resistors. To the right of these is a bottom-right block labeled "BOTTOM RIGHT: ESP32-S3 Board", which connects all GPIO pins to the main bus. Finally, at the bottom center, there are side blocks labeled "SIDES: Ground and +3.3V Rails", which provide the ground and power rails for the entire circuit.

- Battery connector
- Slide switch
- AMS1117 regulator
- Capacitors (filtering)

MIDDLE LEFT: IR Receiver

- Photodiode
- OPA2333 (dual op-amp)
- 10M resistor + 50pF cap (feedback)

MIDDLE RIGHT: IR Transmitter

- TLP291 optocoupler
- IR LED
- Resistors (1.5K, 5.1K, 91Ω)

BOTTOM LEFT: LEDs

- Green, Yellow, Red LEDs
- Current-limiting resistors

BOTTOM RIGHT: ESP32-S3 Board

- All GPIO connections going to above circuits

SIDES: Ground and +3.3V Rails

- Ground bus strip (black)
- +3.3V bus strip (red)

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?

