

ELECTRONICS, WIRING & POWER SYSTEM OF A SELF-BALANCING ROBOT

Manual - 3

Electronics matter as much as mechanics and code.

Bad wiring = vibrations + noise = MPU6050 gives wrong angle = robot oscillates or falls.

This manual makes your wiring **perfect**.

Core Electronics Required

✓ Arduino UNO

Main controller.

✓ MPU6050

Tilt angle sensor (accelerometer + gyroscope).

✓ L293D or L298N

Motor driver.

✓ 2x DC Gear Motors

(150–300 RPM).

✓ Battery

Li-ion 7.4V (2-cell) or 9V rechargeable pack.

✓ Switch + Wires + Connectors

Clean Power Architecture (VERY IMPORTANT)

MPU6050 is extremely sensitive to noise.

Motors create high current spikes and EMI (electrical noise).

If you power MPU from the motor battery directly → WRONG ANGLE + robot oscillation.

The correct power structure:

Battery → Motor Driver (for motors)
Battery → Arduino VIN (for Arduino)
Arduino 5V → MPU6050 (clean power)

Why?

- Arduino's 5V regulator gives a stable, filtered voltage
- MPU6050 gets clean, noise-free power
- Motor noise never reaches the MPU
- Robot becomes stable

NEVER do this:

Battery → MPU directly

or

Motor driver 5V → Arduino 5V

This destroys stability.

MPU6050 Wiring (Most Critical Part)

MPU6050 Connections:

VCC → 5V (from Arduino)
GND → GND
SDA → A4
SCL → A5

Why A4/A5?

UNO uses hardware I²C on these pins.
Fast and stable at 400 kHz.

Put a 0.1μF ceramic capacitor across MPU VCC–GND

This removes high-frequency noise and makes readings 2× more stable.

Motor Driver + Motors

L293D Pin Guide (simple)

Inputs → from Arduino

IN1 → D5

IN2 → D6
IN3 → D9
IN4 → D10

Outputs → to motors

OUT1 & OUT2 → Motor A
OUT3 & OUT4 → Motor B

Enable pins:

ENA → D3 (PWM)
ENB → D11 (PWM)

Power pins:

Motor Power (Vs) → Battery (+)
5V Logic (Vss) → Arduino 5V
GND → common GND

Wiring Diagram

Grounding (Most underrated topic)

All grounds **must be common**:

Battery GND
Arduino GND
L293D GND
MPU6050 GND
→ Must all connect together

If not common:

- MPU readings fluctuate
 - Motors behave randomly
 - Robot cannot balance
 - Complementary filter fails
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EMI & Noise Reduction Techniques

1. Twist the motor wires

Reduces electromagnetic noise.

2. Add flyback diodes (if using raw H-bridge)

L293D already has internal diodes → okay.

3. Mount MPU on thick foam/tape

Reduces vibration.

4. Use short wires

Long wires act like antennas.

5. Add capacitors

- 100nF across motor terminals
- 100μF near motor driver power pin
- 100nF near MPU6050

These improve stability dramatically.

Motor Battery vs Logic Battery

If using L293D:

- You can use **one battery** for everything, but noise is high
- Better: use **Li-ion 7.4V pack** to power motors
- Arduino regulates its own voltage
- MPU gets 5V clean from Arduino

This is the BEST and simplest setup.

Testing Electronics Before Code

Before running any balancing code:

Step 1 — Test motors

Upload simple forward/backward code.
Ensure left & right motors spin correctly.

Step 2 — Test MPU6050

Run the Adafruit MPU6050 example.
Ensure stable readings.

Step 3 — Check noise

Tilt robot slowly → angle must be stable.
If angle jumps randomly → fix wiring.

Final Electronics Checklist

- ✓ Battery → Motor driver
- ✓ Arduino VIN from battery
- ✓ MPU6050 powered ONLY by Arduino 5V
- ✓ A4/A5 used for I2C
- ✓ All grounds common
- ✓ Capacitors added
- ✓ MPU mounted on foam
- ✓ Motor wires twisted
- ✓ Motor driver not overheating

Follow this checklist → you will have **perfect electronics**.
