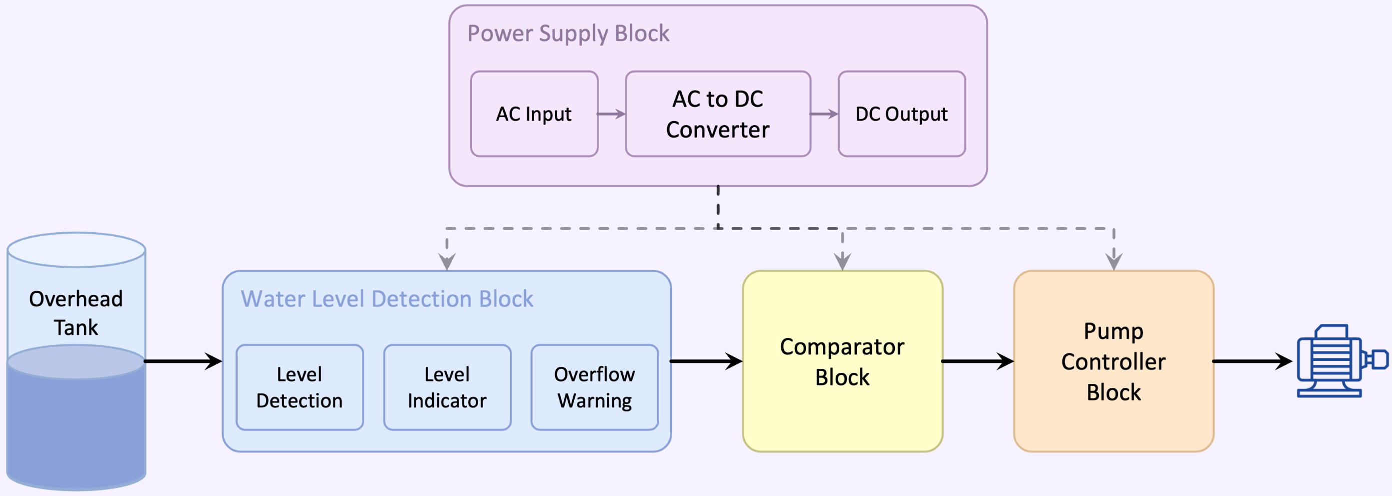
Project Milestone 2

Project Block Diagram



Today we will build the "Power Supply Block" of our project. This block will power up all the components of this project.

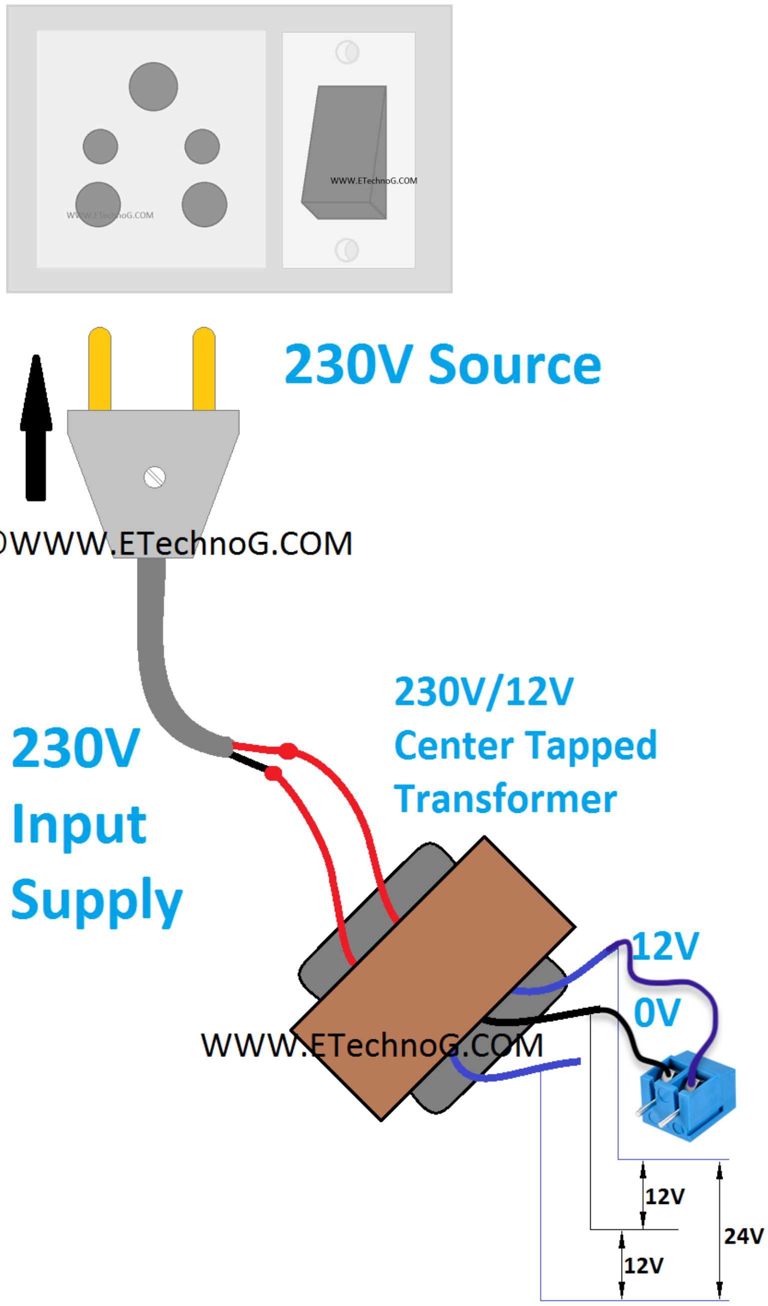
The power supply block will take AC input and generate a constant DC output. We will use the 220V AC from the power supply as the input of this block. Most electronic components and devices, such as microcontrollers, sensors, and actuators, are designed to operate on DC power. In order to use power from the electrical grid, which is in the form of AC power, to operate electronic components, it needs to be converted from AC to DC using a power supply block. This can be done in three steps

- Step down $220 \mathrm{~V}$ AC to $12 \mathrm{~V}$ AC
- Rectification of $12 \mathrm{~V}$ AC
- Voltage Regulation

Step Down AC

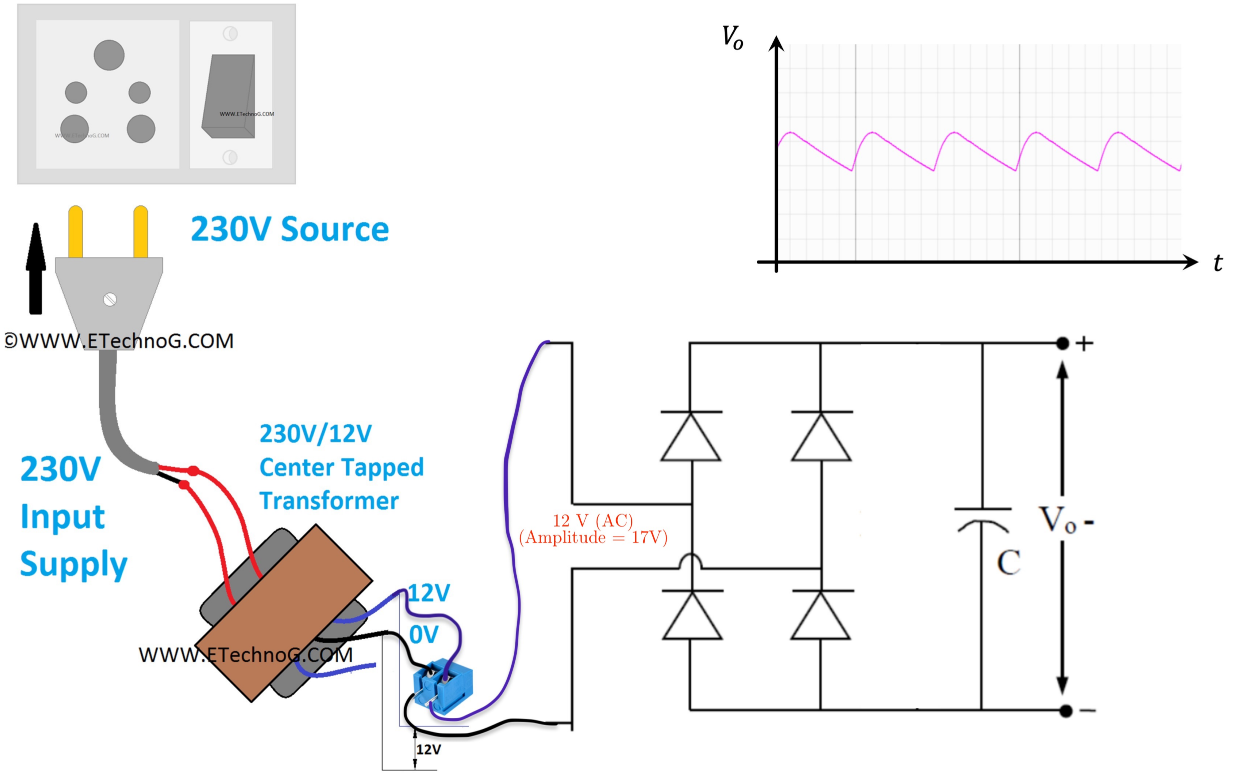
$220 \mathrm{~V}$ AC is a very high voltage for the components of the circuit. Moreover, converting $220 \mathrm{~V}$ AC directly to $5 \mathrm{~V}$ DC would result in significant loss as heat. Hence, we will first use a step-down transformer to reduce the voltage of input to $12 \mathrm{~V}$ AC. In our project, we will use a center-tapped transformer, as shown below.

Here, the two red wires are input ($220\ \mathrm{V}$ AC) and the other wires are outputs. Since this is a center-tapped transformer, we can either get $12\ \mathrm{V}$ AC by using a blue wire and a black wire, or get $24\ \mathrm{V}$ AC by using the two blue wires. **Carefully Connect** the input of the transformer to a wall outlet using a 2-pin AC cord and the output (one blue and one black) to a breadboard using the breadboard screw connectors (blue), as shown below. Be very careful - do not short the input or output terminals. After connecting, observe the output voltage using the oscilloscope.



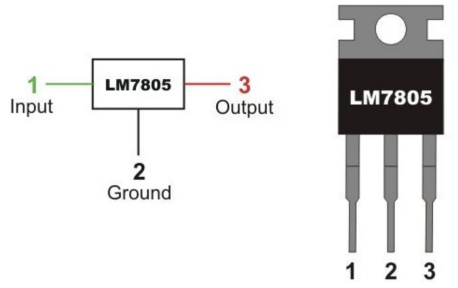
Rectification

The $12\ \mathrm{V}$ AC now can be rectified using the full-wave rectifier circuit we build in the last experiment. Here, do not connect the ouput resistance, only use the capacitors to smooth out the output. The resulting output of the full-wave rectifier will be a DC voltage of around $18\ \mathrm{V}$ with a small ripple voltage. Be careful about the polarity of the capacitors. Observe the output of the rectifier using the oscilloscope.

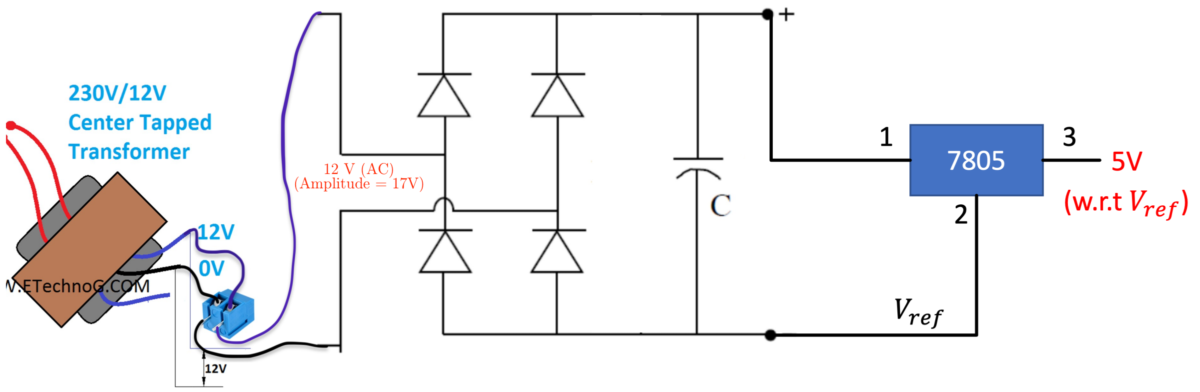


Regulation

From the graph of the output, we can see that a small amount of voltage fluctuation exists. We want to eliminate this fluctuation. To do so, we need a voltage regulator circuit. A voltage regulator is a system designed to automatically maintain a constant voltage level despite changes in input voltage, load current, or temperature. Voltage regulator circuits can be built using **zener diodes**. But we will use a 7805 IC for this project because ICs like the 7805 are more efficient, provide better voltage regulation and have less sensitivity to temperature compared to zener diode regulator circuits. The following figure shows the pin diagram of a 7805 IC.



If we connect a fluctuating input voltage at `pin 1` and `pin 2` (must be greater than 5 V), the output at `pin 3` will be 5 V with respect to ground (pin 2). Therefore, by connecting the output of the rectifier as the input of regulator, we will get a constant 5 V DC voltage. Connect the output to the oscilloscope – `pin 2` at oscilloscope ground and `pin 3` at oscilloscope Ch 1 – and observe the output voltage.



For our project, we need to use op-amps, which require both positive and negative power supplies. Hence, we need both a $+5$ V DC and a -5 V DC. This can be achived by using **two** 7805 ICs connected in a tricky way – by using the $+5$ V output of the first 7805 IC as the ground (instead of V_{ref}) of the second 7805 IC. This way, if we denote the `pin 2` of the ***second*** 7805 IC as GND, the `pin 3` of ***second*** 7805 IC will give $+5$ V DC and `pin 2` of first 7805 IC will give -5 V DC. Connect the oscilloscope in the following manner to observe the outputs: (i) `pin 2` of the ***second*** 7805 IC to GND of the oscilloscope; (ii) `pin 3` of the ***second*** 7805 IC to Ch-1 of the oscilloscope; (iii) `pin 2` of the ***first*** 7805 IC to Ch-2 of the oscilloscope.