AS-06 Mains Power Supplies

Revision sheet

1 Introduction

We need a mains power supply to convert from the 240V AC from the wall socket to a lower voltage for devices to use. These could be as low as ±5V DC for a logic system.

2 Transformers

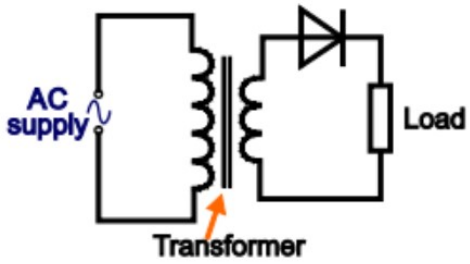
Transformers can step-up the voltage between two coils or step-down the voltage. The equation below links the number of turns and voltages on each coil:

$$\frac{V_S}{V_P} = \frac{\text{Number of turns on secondary}}{\text{Number of turns on primary}}$$

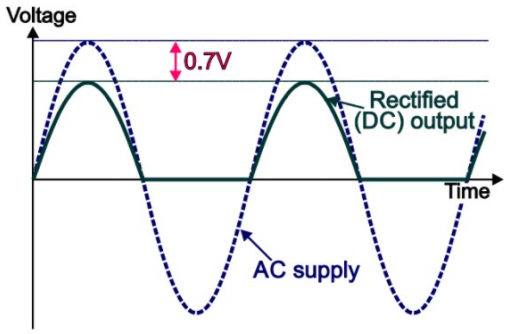
3 Rectification

AC Voltages have positiver areas and negative areas, we want a single positive voltage. To get that, we have to rectify the AC input.

3.1 Half-Wave Rectification

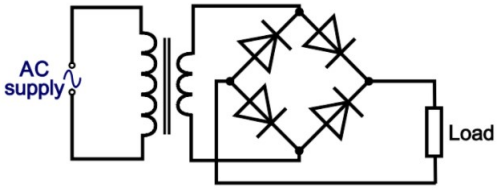


The diode only allows current to flow in one direction. The diode has a 0.7V voltage drop across it.

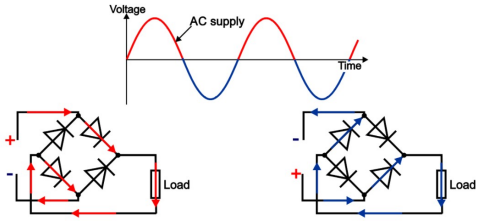


Half wave rectification wastes 50% of the power, this isn't great so we can use a full wave rectification circuit instead.

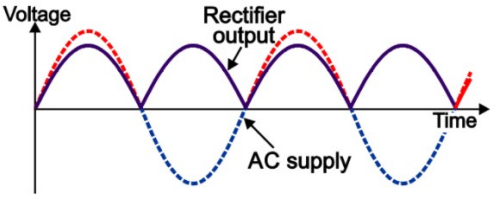
3.2 Full-Wave Rectification



This is a bridge rectifier. It works by a positive voltage flowing through two of the diodes and a negative voltage flowing through the other two. As there are two diodes involved this time, there is a 1.4V voltage drop.

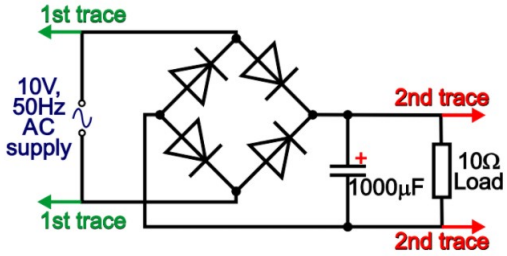


The graph below shows the input and output to the circuit.

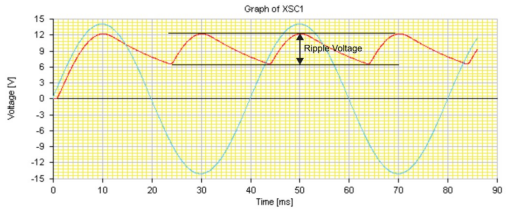


4 Smoothing

We want one consistent V_{out}, not a bumpy one. To get this, we can use a capacitor to 'smooth' the circuit. This isn't a perfect solution however as we still have a slight drop as the capacitor discharges. This is called the ripple voltage.



The output looks something like this:



5 Ripple Voltage

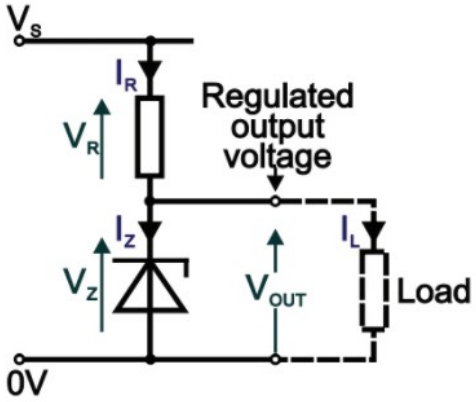
The ripple voltage can be calculated using the following equation:

$$V_R = \frac{I_c}{FC}$$

6 Regulation

The output from smoothing can be relatively smooth but it does have some small bumps. We want a perfectly smooth output, at a single constant voltage. To achieve this, we have to regulate the output.

Regulation is achieved using a component called a Zener Diode. When it is in reverse bias, the Zener Diode has a specified voltage across it, therefore it can be sued a sa voltage reference. They also require a minimum current to flow through them (called a 'holding current').



If the load current draw is above the maximum load current which can be provided whilst keeping the zener holding current then the Zener will switch off.