

Activity Sheet : Week 9 Studio 2

Building a DC power supply

Time	Duration	Activity
0:00	30 mins	Briefing
0:30	30 mins	Activity #1a: Working with step-down transformer
1:00	60 mins	Activity #1b: Setting up & testing a full-bridge diode rectifier circuit
2:00	40 mins	Activity #1c: Adding capacitor filter to reduce voltage ripple at the rectifier output

This is a team-activity with two students per team

Learning Outcomes

To be able to

- Use a step-down transformer
- Build a full-bridge diode rectifier
- Design capacitor filter to smoothen output of diode bridge rectifier

Equipment & Components

- Step-down transformer
- Power Diodes 1N4000 X 4
- Electrolytic capacitor, $3300\mu F$
- Power resistor, 39Ω , $5W$
- Resistor, $1.2k\Omega$, $0.25W$
- Oscilloscope

Key Concepts

- Diode bridge rectifier converts AC voltage to DC with average output of $\frac{2V_m}{\pi}$, where V_m is the peak amplitude of the AC voltage. However, there is a large amount of ripple.
- A capacitor filter is used to smoothen the rectifier output. If ΔV_0 is the peak-to-peak ripple then

$$\Delta V_o \approx \frac{V_o}{RC} \times \frac{T}{2} \quad (1)$$

$$= \frac{V_o}{2fRC} \quad (2)$$

where T is the period of the AC voltage.

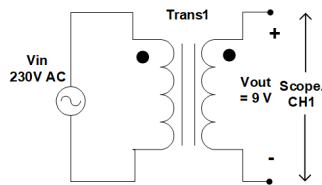
Activity #1a: Working with a step-down transformer

Figure 1: Step-down Transformer

- Connect transformer secondary to oscilloscope as shown in Figure 1
- Observe the transformer secondary voltage on the oscilloscope.
- Measure the maximum and RMS voltage and note them down in your log book.

Many devices like mobile phones and LED lights need DC power supply to work. However, the electricity available at home and office is AC. Hence, it is necessary to convert AC to DC. We use an AC-DC converter, known as rectifier, to do this.

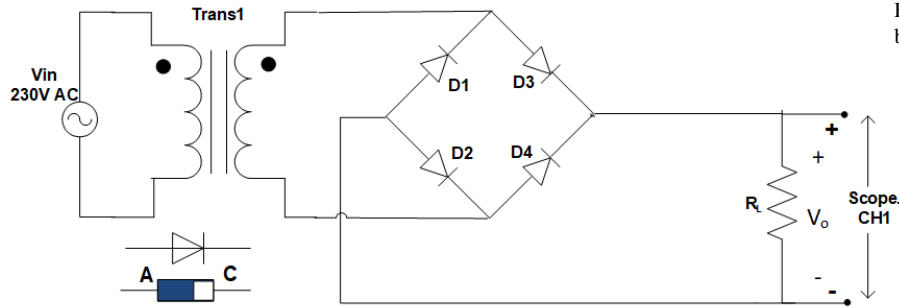
Activity #1b: Setting up & testing a diode-bridge rectifier circuit

Figure 2: Step-down Transformer and diode bridge rectifier

- Setup a diode-bridge rectifier circuit as shown in the Figure 2 using four IN4001 diodes.
- Connect the 39Ω , 5 W resistor at the output of the rectifier. This will draw a current of approximately 0.3A. **(PLEASE TAKE NOTE THAT THE RESISTOR WOULD GET HOT. DO NOT TOUCH THE RESISTOR NOR KEEP THE CIRCUIT ON FOR MORE THAN 1 MIN.)**
- Observe ONLY the voltage across R_L on CH1 and note down its V_{max} , V_{min} , V_{pp} and V_{ave} .

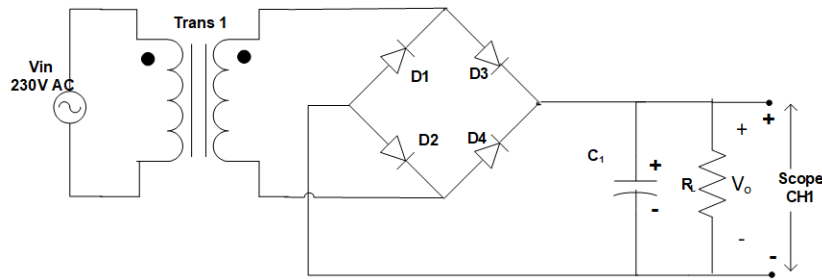
Activity #1c: Adding capacitor filter to reduce voltage ripple

Figure 3: Step-down Transformer and diode bridge rectifier with capacitive filter



Figure 4: Electrolytic Capacitor

- Identify the positive and negative leads of the electrolytic capacitor : adjacent to the negative lead, there is a white strip running through the length of the capacitor and marked with a \diagup as shown in Figure 4.
- **BE CAREFUL TO USE CORRECT POLARITY OF THE CAPACITOR.**
- Connect the capacitor with correct polarity across the load resistor.
- Measure the output voltage using oscilloscope and record them in Table 1.
- Change the load resistance to a higher value ($1.2\text{ k}\Omega, 0.25\text{ W}$) and repeat the above mentioned measurements.
- You may increase the capacitance by twice its value or higher and then observe the effect of increasing the filter capacitance on the output voltage ripples and justify your observation using appropriate equation.

	$V_{O,MAX}$	$V_{O,MIN}$	$V_{O,PP}$	$V_{O,AVE}$
$R_L = 39\Omega, 5W$				
$R_L = 1.2k\Omega, 0.25W$				

Table 1: Output voltage with capacitor filter