5 V Charger Using a Low Pass Filter

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Contents

1 Aim

The aim is to build a working mobile charger. The circuit must output 5 V DC to charge a mobile phone after taking 230 V AC as input.

2 Materials Required

- Breadboard
- Printed circuit board
- 12-0-12 Tranformer
- 4 diodes
- 100 µF Capacitor
- 7805 Regulator
- Several electrical wires
- Soldering iron and wire
- Multimeter
- Cathode-ray oscilloscope
- Output pin
- USB cable
- Mobile phone

3 Circuit Diagram

Here is a full picture of mobile charger

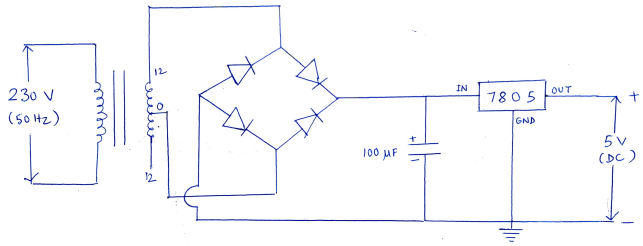

Fig. 3.1: Circuit diagram of a mobile charger

4 Circuit Explanation

4.1 Transformer

The transformer steps down the 230 V AC main supply to 12 V AC. Note that these are RMS voltages. The peak voltage will thus be $12\sqrt{2} \approx 20$ V. The transformed voltage is given by

$$v(t) = 12\sqrt{2}\sin(100\pi t + \phi)\,\text{V} \tag{4.1}$$

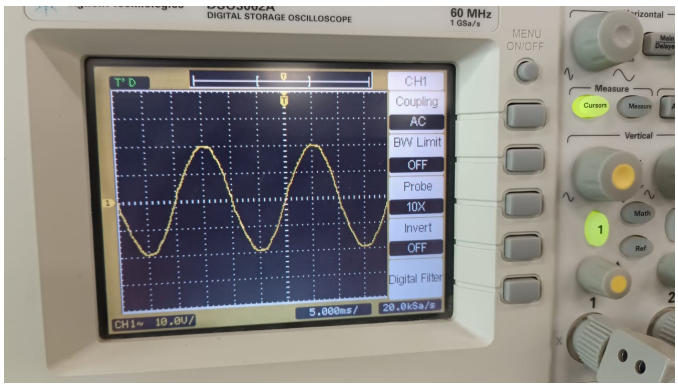

Fig. 4.1: CRO output after transformer

4.2 Rectifier

The full-wave rectifier is realized using four Si diodes arranged in a bridge form as shown in Circuit Diagram. The output waveform at this stage is a DC 12 V, 50 Hz rectified sinusoid.

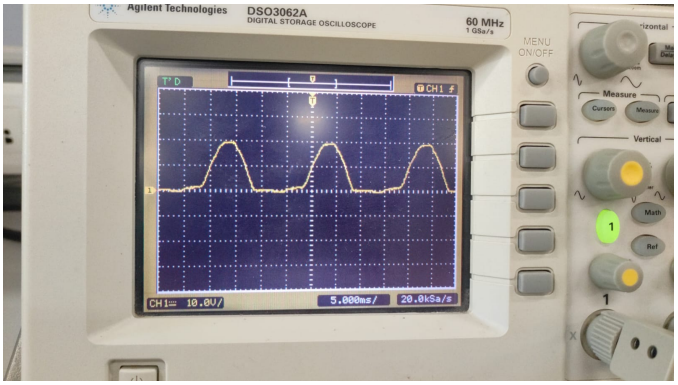

Fig. 4.2: Output half-wave rectified waveform across diode .

4.3 Filter

The 100 *mu*F capacitor acts as a first order analog low pass filter. It filters around the zero frequency DC component and partially eliminates the even harmonics associated with the rectified sinusoid. The output waveform at this stage consists of the constant DC component. Note there is no gain and hence we require a regulator to obtain the required DC 5V supply.

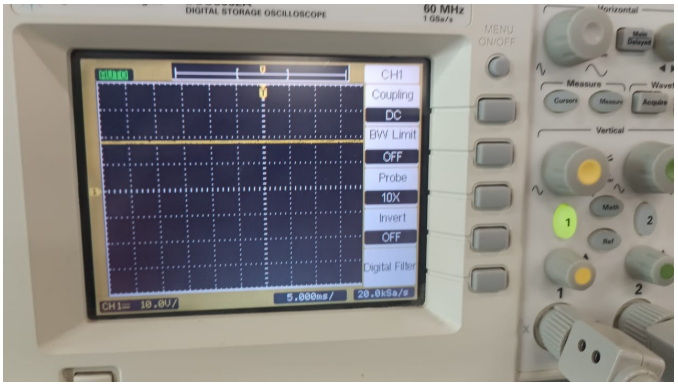

Fig. 4.3: Output DC waveform at filter stage .

4.4 Regulator

The regulator used in this circuit is a 7805 regulator, which outputs a constant DC supply of 5 V with very little ripple through a feedback mechanism. The regulator will work because the DC component associated with the rectified waveform is

$$V_{DC} = \frac{2V_p}{\pi} = \frac{2 \times 12\sqrt{2}}{\pi} > 5\,\text{V} \qquad (4.2)$$

where V_p is the peak voltage. Thus, we obtain an almost constant supply of 5 V DC to charge a mobile phone.

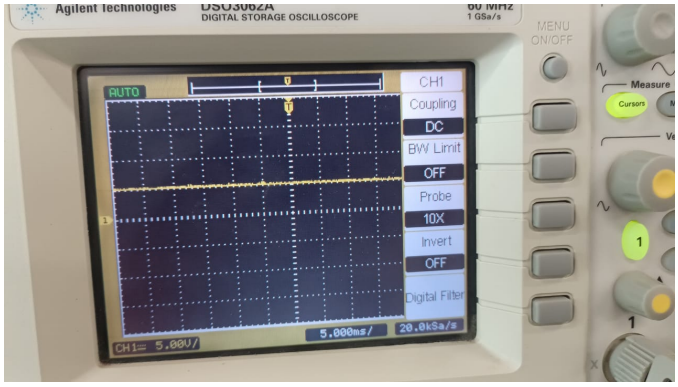

Fig. 4.4: Output DC waveform at regulator stage.

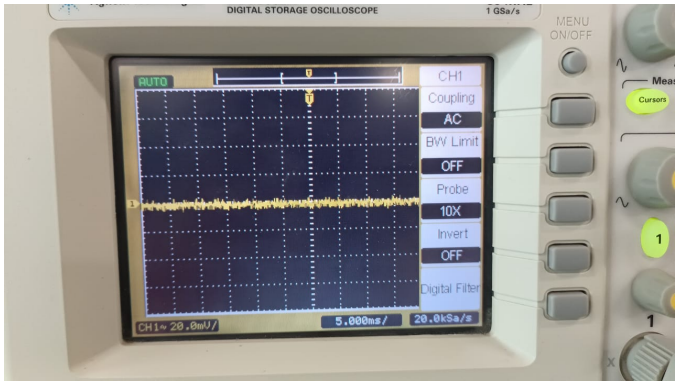

Fig. 4.5: Output AC ripple at regulator stage .

5 Results

1) Peak voltage after transformer and rectifier stage, $V_p = 18\,\text{V}$.
2) DC component after filter stage, $V_{DC} = 18\,\text{V}$.
3) DC component after regulator stage, $V'_{DC} = 5\,\text{V}$.
4) Ripple after regulator stage, $\epsilon = 5\,\text{mV}$.

6 Learning Outcomes

1) Working and implementation of a low-pass analog filter.
2) Use of regulator to help realise an analog low-pass filter with very low cutoff frequency.
3) Use of lab equipment such as solder, oscilloscope, breadboard, PCB, etc. to realize a circuit.