5-V Charger Using a Low Pass Filter

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Contents

***Abstract*—This is a lab report on the realization of a 5 V charger using a low pass analog filter.**

1 Circuit Description

The key components of the charging circuit are:

1) Step-down transformer (12-0-12)
2) Full-wave bridge rectifier
3) RC filtering circuit
4) 5 V Regulator (7805)

The schematic diagram of the entire circuit is shown in Fig. 1.1.

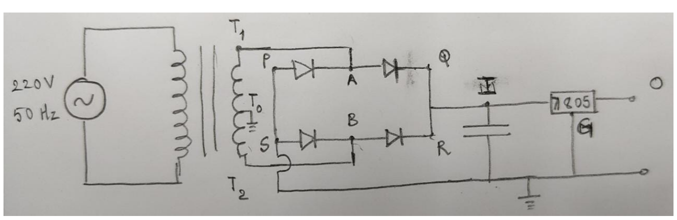

Fig. 1.1: Schematic diagram of the circuit

1.1 Transformer

The transformer used is a centre-tapped 12-0-12 step-down transformer. The ground and one of the output wires is used in the charging circuit. The output waveform at this stage is a 12 V, 50 Hz AC sinusoid.

1.2 Rectifier

The full-wave rectifier is realized using four Si-diodes arranged in a bridge form as shown in Fig. 1.1. The output waveform at this stage is a DC 12 V, 50 Hz rectified sinusoid.

1.3 Filter

This is the main component of the charging circuit. 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.

1.4 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

$$V_{DC} = \frac{2V_p}{\pi} = \frac{2 \times 12\sqrt{2}}{\pi} > 5\,\mathrm{V} \tag{1.1}$$

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

2 Results

The screenshots of the waveforms at each stage are shown ahead.

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

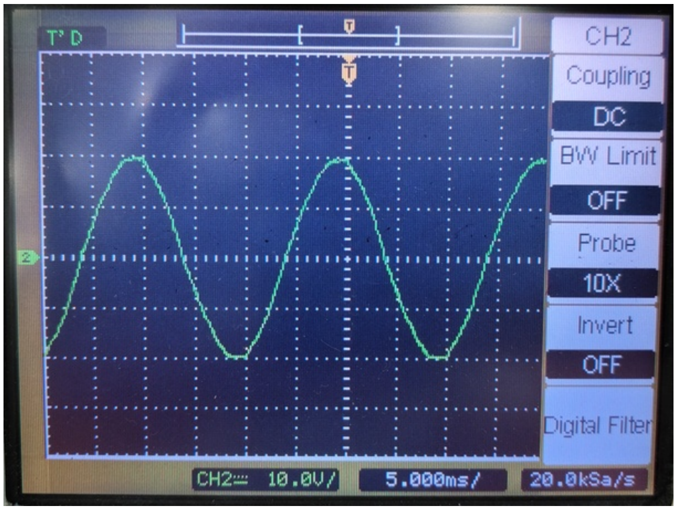

Fig. 2.1: Output AC waveform at transformer stage across T_1T_0 (18 V peak).

Fig. 2.2: Output half-wave rectified waveform across diode across AQ (18 V peak).

3 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.

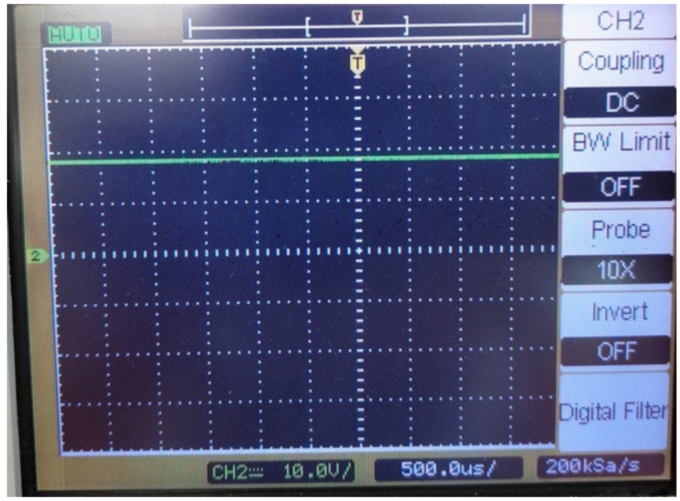

Fig. 2.3: Output DC waveform at filter stage across IS (18 V).

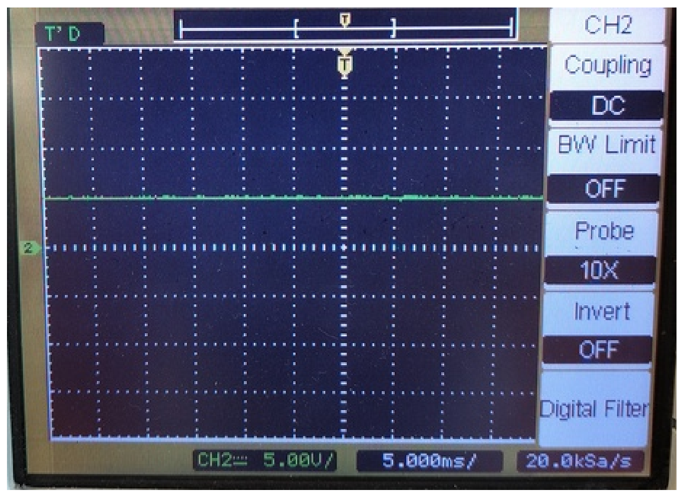

Fig. 2.4: Output DC waveform at regulator stage across OG (5 V).

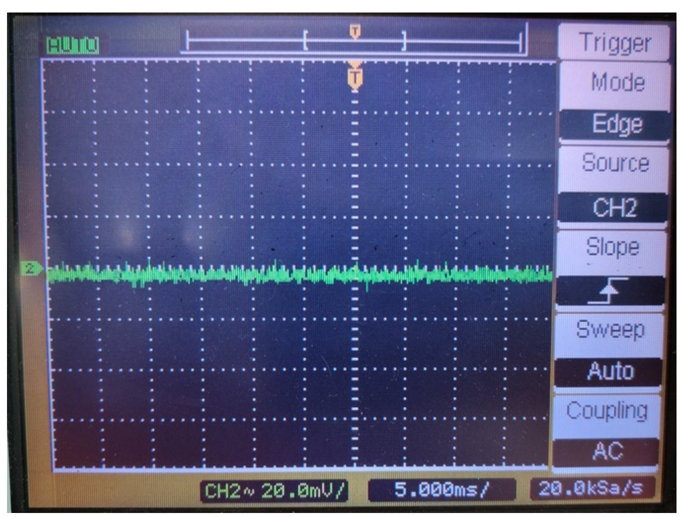

Fig. 2.5: Output AC ripple at regulator stage across OG (5 mV).