TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Lab 3 – Diode Applications

XMUT204 Electronic Design

Topics

Objectives

- Working with diode clipper and clamper circuits.
- Measuring the characteristics of zener diode.
- Measuring voltage regulation.

Diode Clipper Circuit

- Diodes may be used in a number of ways to change the shape or form of a signal. For example, the diode clipper of Fig. 1a may be used to limit the amplitude of an ac signal.

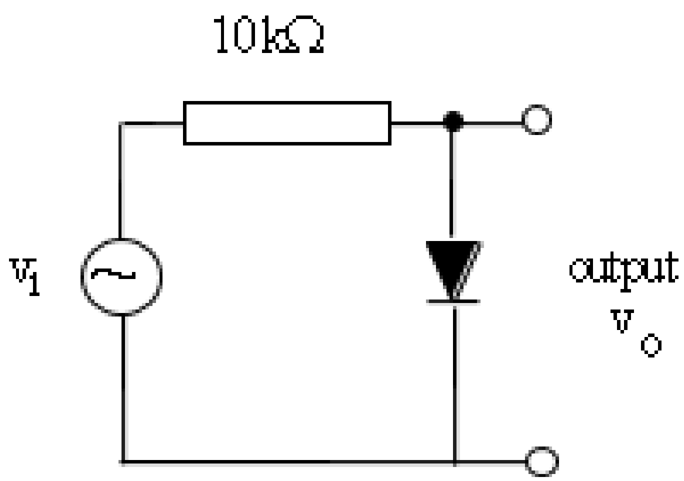


Fig. 1a: Clipper circuit

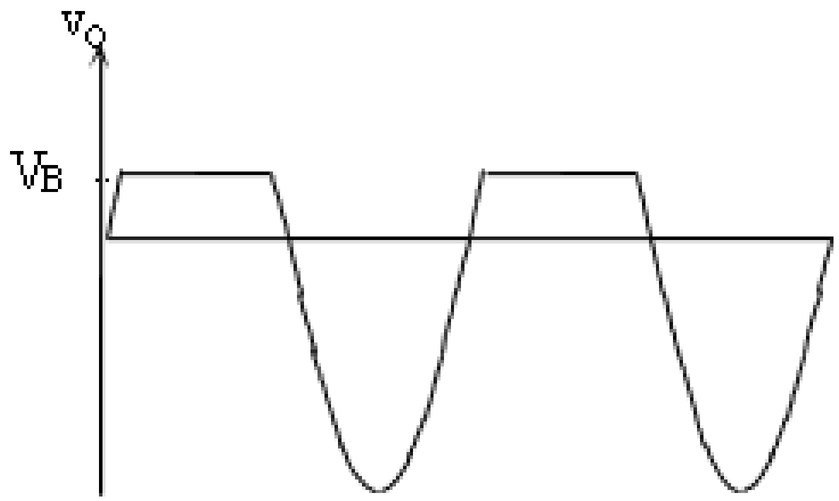


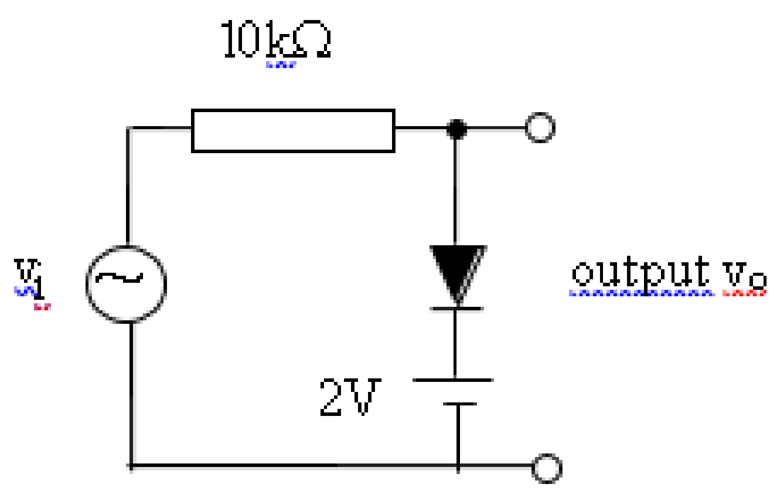
Fig. 1b: Clipper waveforms

a. Set up the circuit of Fig. 1a. Use the signal generator at 1 kHz to provide an input sinusoidal signal at 8 V_{pp}. Display both *vi* and *vo* on the oscilloscope (use dc coupling). The output *vo* should be as shown in Fig 1b.

Diode Clipper Circuit

b. Using the constant drop model for the diode (see Lab 2 handouts) explain this result.

Insert the dc power supply (set to 2 V) between the diode and ground as shown in the Fig. 2 given below.

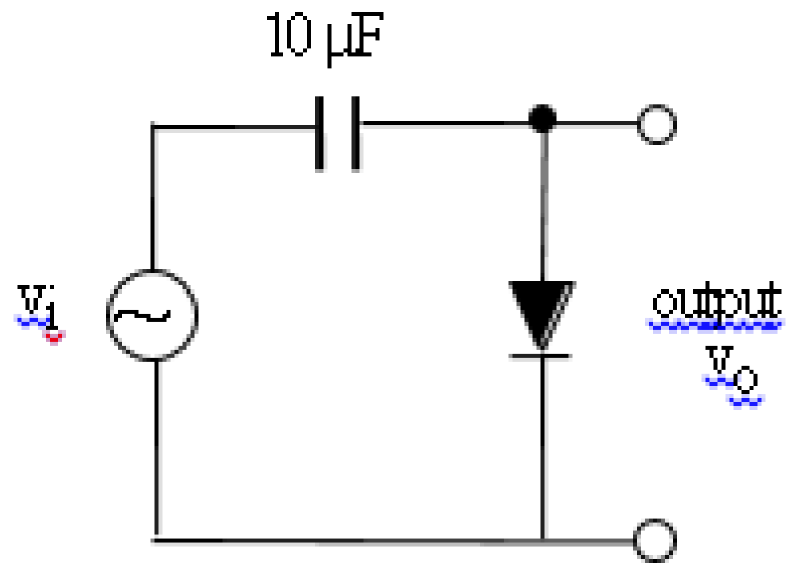


c. Sketch *vo* and explain its form.

d. Remove the dc power supply and reverse the diode. Sketch *vo* and explain its form.

Diode Clamper Circuit

- Diodes may be used to control the peak values of an ac signal in a circuit, i.e. to hold (clamp) its dc level at a predetermined value.



a. Replace the 10 kΩ resistor in Fig. 1a with a 10 µF capacitor (Fig. 3); again use dc coupling on the oscilloscope coupling.

b. Sketch *vi* and *vo*. Measure (using the DVM) the voltage drop *Vc* across the capacitor and explain the operation of the circuit.

Diode Clamper Circuit

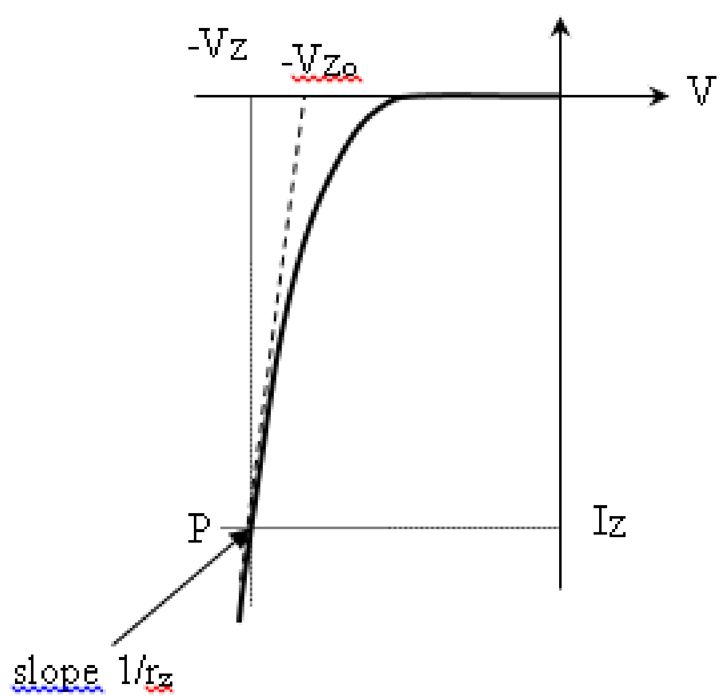
Note:

- As *vi* initially goes positive, the diode conducts and the capacitor is charged up; when *vi* starts to fall from its peak value, the diode becomes reversed biased and the capacitor cannot discharge.

- $vo = vd = vi - Vc$

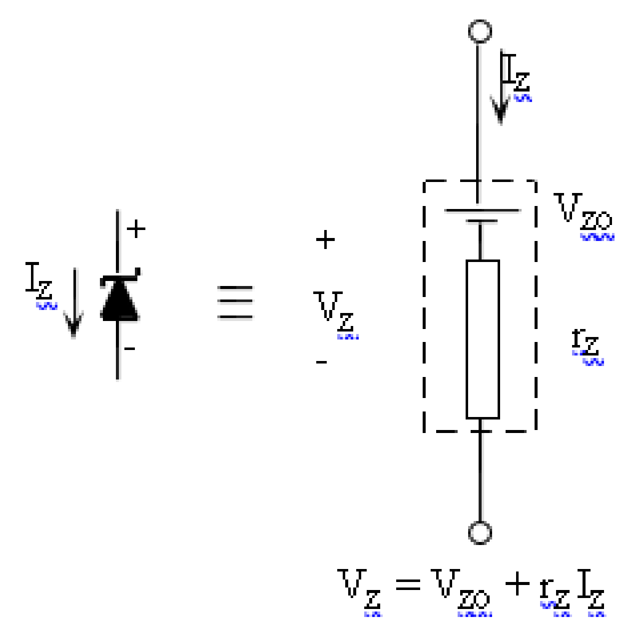
Introduction to Zener diodes

- If a sufficiently large reverse bias is applied to a semiconductor diode, a significant current will start to flow at the "breakdown" voltage.
- Zener diodes are manufactured to withstand this breakdown effect up to some specified power rating. They are used as voltage regulators
- The I-V characteristics in the breakdown region are shown in Fig.



zener characteristics

Fig. 4a: Zener diode V-I curve



zener symbol

zener model

Fig. 4b: Zener diode model

Introduction to Zener diodes

- A zener is specified by its voltage *Vz* at some test current I_Z (point P), its power rating and its incremental resistance *rz*, the inverse of the slope of the characteristic at Iz .

- This line cuts the *V* axis at *Vzo*.

- The I-V relationship may be modelled by the combination of a voltage source V_{Z_o} and resistance r_Z shown in Fig. 4b.

Measure the Characteristics of Zener Diode

- Set up the circuit of Fig. 5.

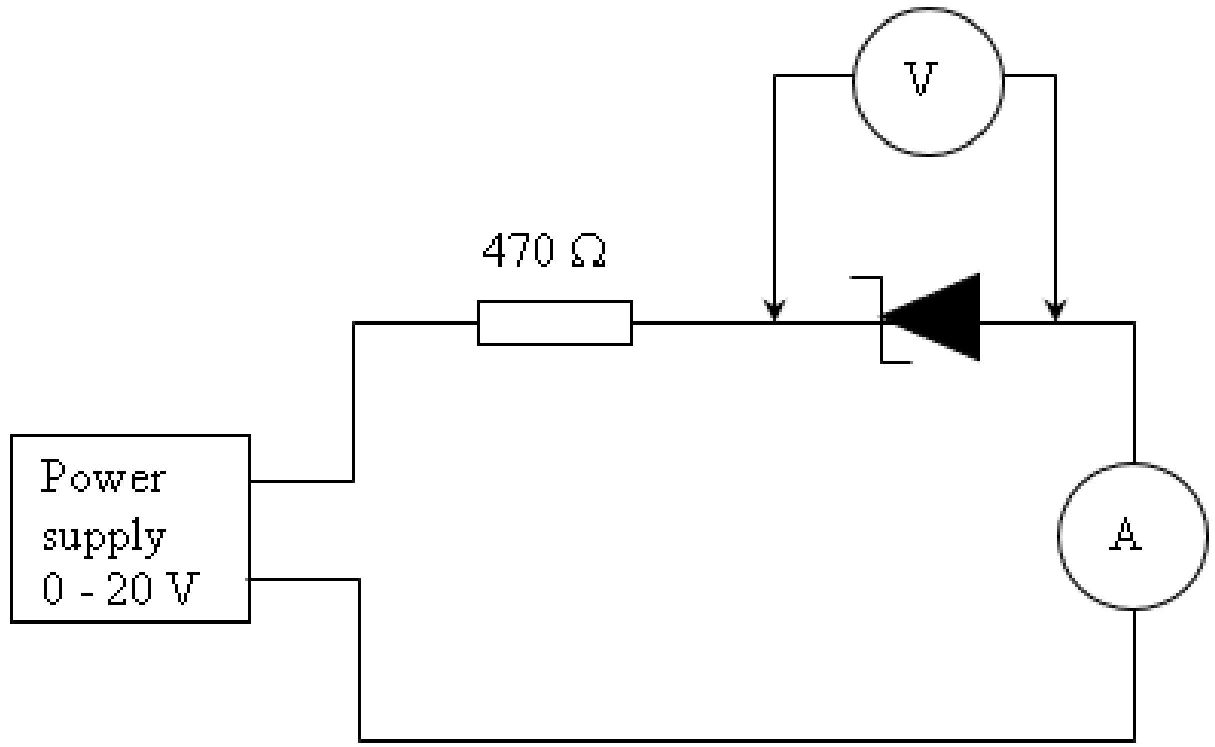


Fig. 5: Zener diode measurement circuit

a. Record values of *Vz* for the following values of *Iz* (in mA): -3, -6, -10, -15, -17.5, -20, -22.5 and -25.

b. Plot I_Z against V_Z. For a value of *Iz* =-20 mA, determine *rz* and *Vzo* (Fig. 4a).

Measure Voltage Regulation

a. For the circuit of Fig.5, measure the change in *Vz* when the voltage supply is changed from +12 to +14 V.

Calculate the change in the output / the change in the input. This is known as the *line stability ratio*.

b. By modelling the zener diode as shown in Fig. 4b, calculate (using your measured values for r_z) what you would expect the line stability ratio to be. Compare your result with this value.

Report

Part C: Report

- Complete a short report by answering the questions from the associated question sheet.

Equipment

- Resistor: 470Ω, 10kΩ, 100kΩ, and 1MΩ
- Capacitor: 10 uF
- Diode: 1N4148, 1N746A (3.3 V)