

## EXPERIMENT #3

## PRECISION RECTIFIERS

### I OBJECTIVES

The primary objective of this experiment is to familiarize the student with half wave rectifier and precision full wave rectifier. We should all know that a diode can be used as a rectifier. We also know that a diode usually drops about 0.7 volts across it when conducting. When needed to rectify very small A.C. signals diodes and op-amps can be used to make the diode function more like an ideal diode.

### II INTRODUCTION

The precision full-wave rectifier transmits one polarity of the input signal and inverts the other. Thus both half-cycles of an alternating voltage are transmitted but are converted to a single polarity of the circuit's output. The precision full wave rectifier can rectify input voltages with millivolt amplitudes. This type of circuit is useful to prepare signals for multi applications, averaging or demodulation. The precision rectifier is also called an *absolute-value* circuit.

### III COMPONENTS AND INSTRUMENTATION

The focus is on the 741-type op amp provided one per IC, in an 8-pin dual-in-line (DIP) package whose schematic connection diagram and packaging are shown in fig. 3.1. For power, use two supplies.  $\pm 15$  V for short. As well, you need a variety of resistors. For measurement, use a bench multimeter with ohms scale, a two channel oscilloscope and a function generator.

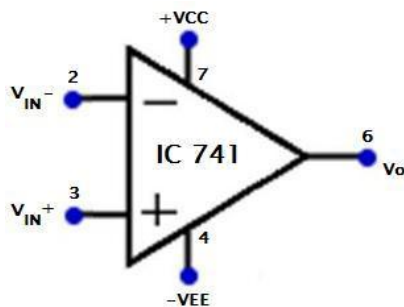


Fig 3.1(a) Symbol

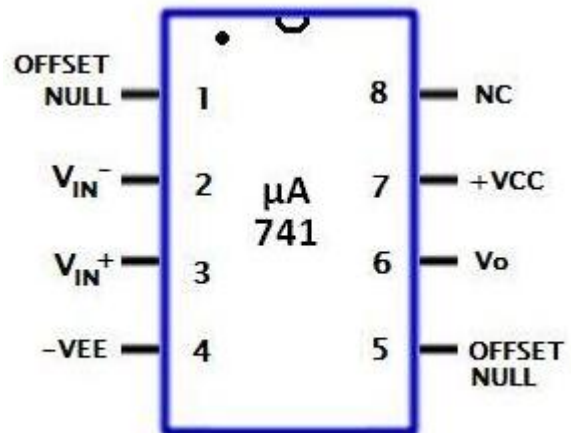


Fig 3.1(b) Pin diagram of  $\mu A741$

### IV PREPARATION

Q1 For the circuit given in Fig 3.2 use each of the diode models A and B (Fig.3.3) and determine the values of  $V_o$  and  $V_{ao}$ :

a) When  $V_{in} = 2 \text{ V dc}$  model A  $V_O =$   $V_{ao} =$

model B  $V_O =$   $V_{ao} =$

b) When  $V_{in} = -3 \text{ V dc}$  model A  $V_O =$   $V_{ao} =$

model B  $V_O =$   $V_{ao} =$

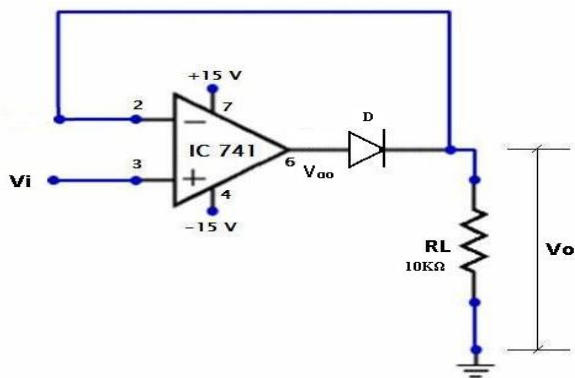


Fig. 3.2. Precision Half-Wave Rectifier

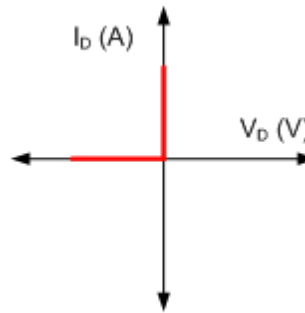


Fig. 3.3(a) . Model A

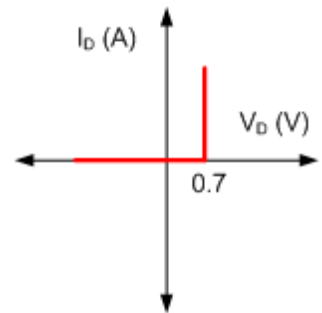


Fig. 3.3(b) . Model B

Q2 Compare diode models A and B by sketching  $V_O$  and  $V_{ao}$  with respect to time given  $V_i = 5 \sin 2\pi ft$  for the rectifier circuit shown in Fig. 3.2 Assume  $f = 100 \text{ Hz}$ .

Q 3 Sketch and label the Voltage Transfer Characteristics (VTC) of the circuit of Fig.3.4 if  $R_2=2R_1$  and the non-inverting input of the op amp is connected to a -5V reference voltage (instead of to ground). Sketch and label  $V_O$  if  $V_i$  is a sinusoidal waveform with peak values of  $\pm 10\text{V}$ .

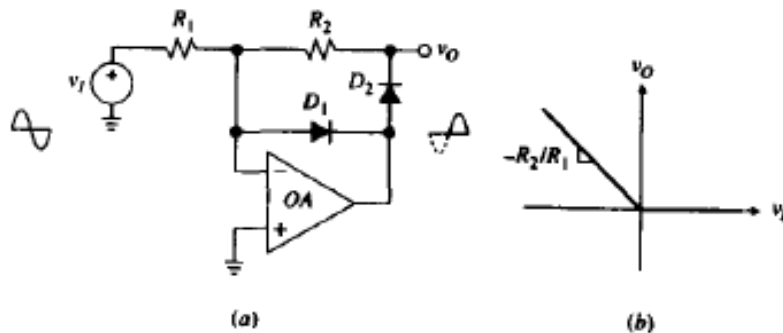


Fig. 3.4

V EXPERIMENTATION

5.1 – Precision Half wave Rectifier - A

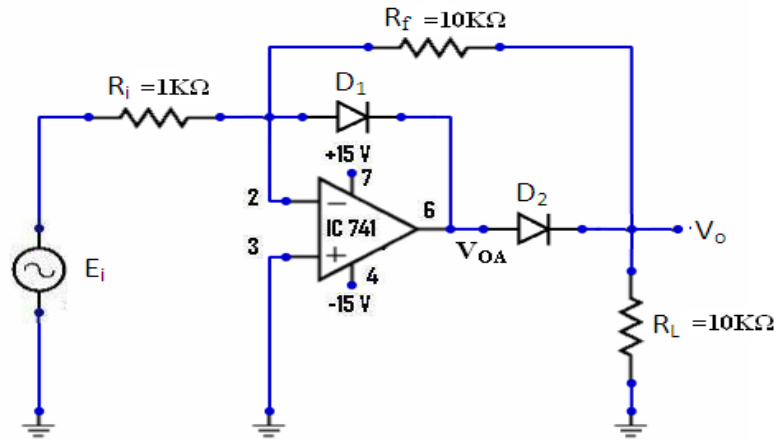


Fig 3.5. Precision Half-Wave Rectifier – A

- 1) Build the precision half wave rectifier circuit shown in fig. 3.5.
- 2) Use a square wave signal of 1V(peak to peak) and a period of 10 ms for  $V_{in}$ . Record  $V_o$ .
- 3) Use a triangle wave signal of 1V(peak to peak) and a period of 10 ms for  $V_{in}$ . Record  $V_o$ .
- 4) Capture  $V_o$  versus  $V_{in}$  in x-y mode and record the detail.
- 5) Increase the frequency from 500Hz to 1MHz in steps of one decade and note  $V_o$ (peak) in Table 3.1.

(The waveforms can be plotted on ordinary graph sheets, to be attached with report.)

Table 3.1

$V_{in}$ (V) (Peak)	Frequency (kHz)	Square Waveform $V_o$ (V) (Peak)	Triangle Waveform $V_o$ (V) (Peak)
0.5	0.5		
	5		
	50		
	500		
	1000		

**E 5.2 – Precision Half wave Rectifier - B**

**Draw the circuit of Fig.3.5, with reversed polarities for the two diodes.** This is the precision HWR – configuration B.

- 1) Build the precision rectifier circuit shown in Fig.3.6
- 2) Use a square wave of 1V(peak to peak) and a period of 10 ms. for  $V_{in}$ . Record  $V_O$ .
- 3) Use a triangle wave of 1V(peak to peak) and a period of 10 ms. for  $V_{in}$ . Record  $V_O$ .
- 4) Capture  $V_O$  versus  $V_{in}$  in x-y mode and record the detail.
- 5) Increase the frequency from 500Hz to 1MHz in steps of one decade and note  $V_O(\text{peak})$  in Table 3.2.  
(The waveforms can be plotted on ordinary graph sheets, to be attached with report.)

**Fig 3.6. Precision Half-wave Rectifier - B**

**Table 3.2**

$V_{in}$ (V) (Peak)	Frequency (kHz)	Square Waveform $V_o$ (V) (Peak)	Triangle Waveform $V_o$ (V) (Peak)
0.5	0.5		
	5		
	50		
	500		
	1000		

*E 5.3 – Precision Full-wave Rectifier*

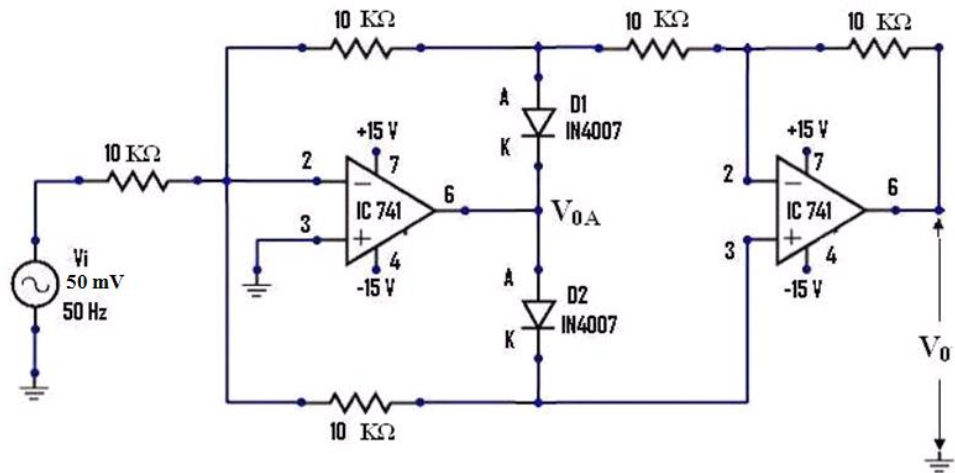


Fig 3.7 Precision Full-wave Rectifier

- 1) Connect the circuit as per Fig. 3.7
- 2) Give a sinusoidal input of 100 mV(peak to peak), 1 kHz from a signal generator.
- 3) Switch on the dual power supply and note down the output at nodes  $V_{0A}$  and  $V_0$ .
- 4) Increase the frequency of the sine wave until distortion occurs. Note the frequency. Record  $V_0$ .  
(The waveforms can be plotted on ordinary graph sheets, to be attached with report.)

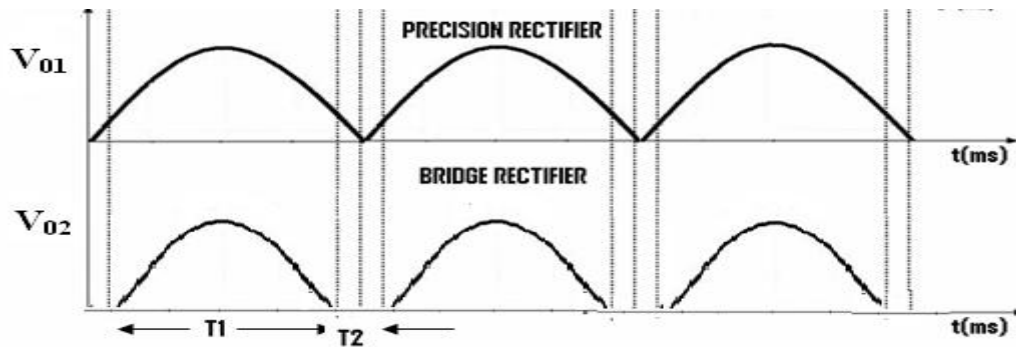


Fig 3.8. Comparison of waveforms

**VI INFERENCE \ CONCLUSIONS**