# Operation and Simulation of single phase half wave uncontrolled Rectifier

## 1. Instructional Objectives

On completion the student will be able to

- Analyze the operation of single phase half wave rectifier supply resistive, inductive loads.
- Define and calculate the characteristics parameters of the voltage and current waveforms
- Simulate the circuit with computer software package (MATLAB)

## 1.1 Introduction

One of the first and most widely used application of power electronics devices have been in rectification. Rectification refers to the process of converting an ac voltage or current source to dc voltage and current. Rectifiers specially refer to power electronic converters where the electrical power flows form the ac side to the dc side. In this lesion the working principle and analysis of half wave uncontrolled rectifier circuits supplying different types of loads (resistive, inductive) will be presented.

**Points of interest in the analysis will be**

- Wave form and characteristics values (average, RMS) of the rectified voltage and current

- Influence of the load type on the rectified voltage and current.


In the analysis, following simplifying assumptions will be made

- The internal impedance of the ac source is zero
- Power electronic devices used in rectifier are ideal switches

## 1.2 single phase uncontrolled half wave rectifier

This is the simples and probably the most widely used rectifier circuit albeit(although) at relatively small power levels. The output voltage and current of this rectifier are strongly influenced by the type of the load. In this section, operation of this rectifier with resistive, inductive loads will be discussed.
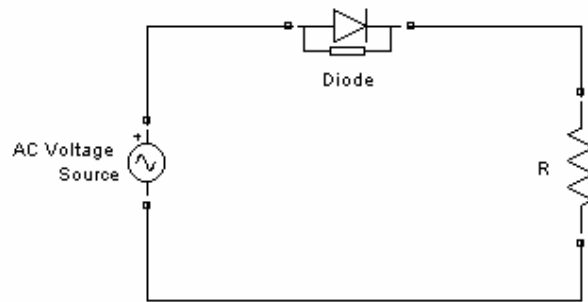
(a)
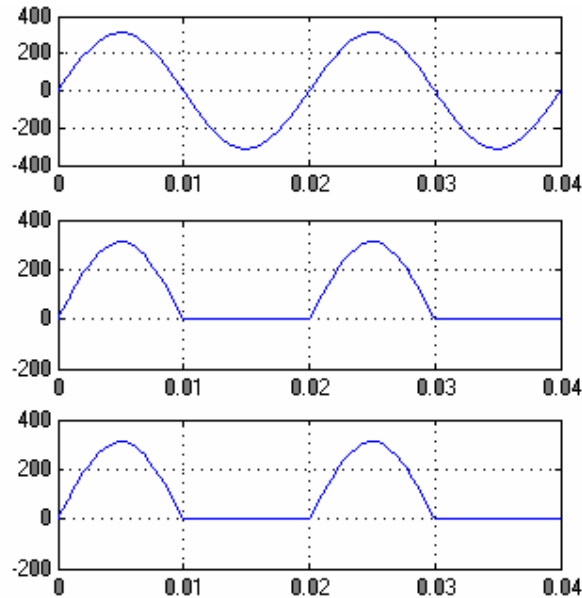


(b)

Fig..1.1 Single phase uncontrolled half wave rectifier with resistive load.
(a) Circuit diagram; (b) wave forms.

Fig 1.1 shows the circuit diagram and the waveforms of a single phase uncontrolled half wave rectifier. If the switch S is closed at t=0, the diode becomes forward biased in the interval 0<t<0.01

$$v_0 = v_i = \sqrt{2}V_i \sin \omega t$$

Since the load is resistive

$$i_0 = \frac{v_0}{R}$$

for t>0.01, vi becomes negative and D becomes reverse biased. So in the interval 0.01<t<0.02

$$v_0 = i_0 R = 0$$
$$i_0 = 0;$$

Form these relationships

$$V_{0AV} = \frac{1}{0.02} \int_{0}^{0.02} v_0 d\omega t = \frac{\sqrt{2}V_i}{\pi}$$

$$V_{0RMS} = \sqrt{\frac{1}{0.02} \int_{0}^{0.01} V_0^2 d\omega t} = \frac{V_i}{\sqrt{2}}$$
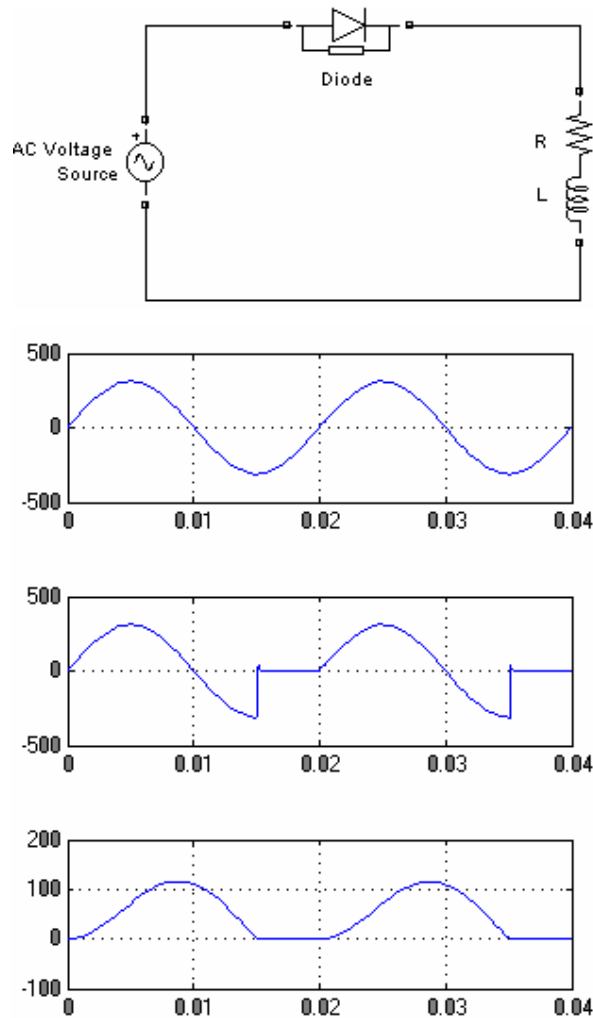
**1.2.1 With RL load**



Fig..1.1 Single phase uncontrolled half wave rectifier with RL load.
(a) Circuit diagram; (b) wave forms.

As in the previous case, the diode is forward biased when the switch S is turned on. at t=0. However, due to the load inductance the output current (i0) increases more slowly. Eventually at t=0.01, the output voltage (vo) becomes zero again. However, i0

still positive at this point. Therefore, diode continues to conduct beyond t=0.01 while the negative supply voltage is supported by the inductor till its current zero at t=0.014 beyond this point, diode becomes reverse biased. Both vo and io remains zero till the beginning of the next cycle where upon the process repeats.
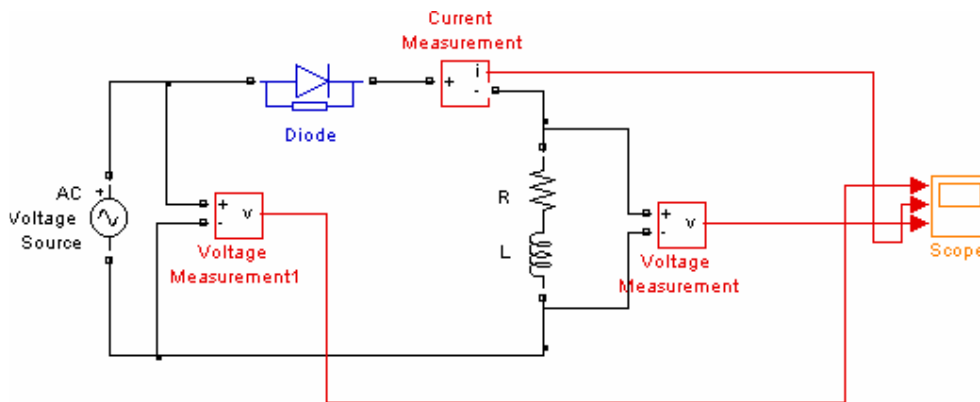
For 0<t<0.014

$v_0 = v_i$

$i_0 = i_i$

For 0.014<t<0.02

$v_0 = 0$

$i_0 = 0$

## 1.3 Computer simulation

The above said circuit will be simulate using MATLAB/SIMULINK software
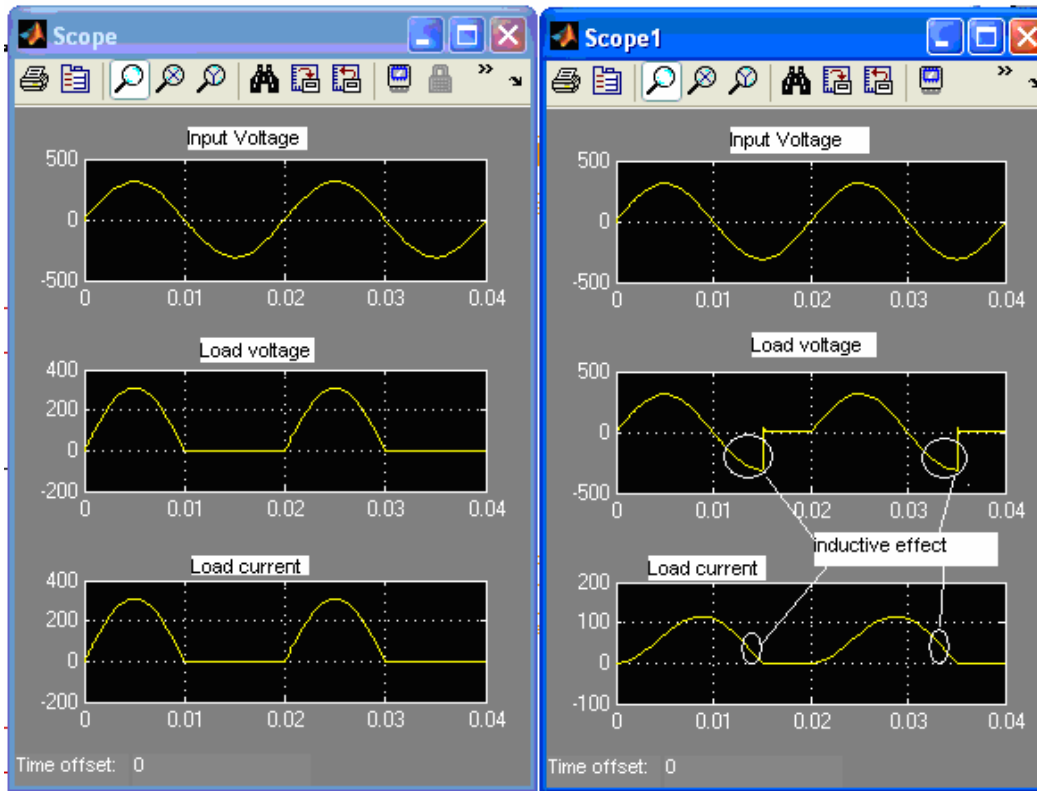
### 1.3.1 Simulation diagram



**Design parameters**

Vi=sqrt(2)*220
f= 50Hz
R=1 Ohms
L=0.012 H

## 1.3.2 Simulation Waveform



(a) R LOAD             (b) RL LOAD

**Reference:**

1. Prof. Sabyasachi Sengupta and et.all, "NPTEL Power Electronics Notes"