

1Ph_HW_Converter_R-L_Load -- Overview



Dr. Ashish Shrivastava
Professor & Head
Electrical Engineering Department
JRE Group of Institution, Noida (UP)



1-PHASE HALF WAVE CONTROLLED CONVERTER WITH R-L LOAD

Objective:

After performing this lab exercise, learner will be able to:

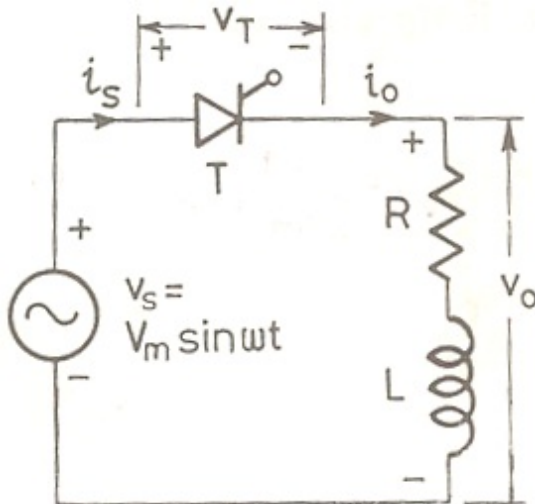
- Understand the working of 1-phase half wave control converter with R-L load.
- Learn the role of Power Electronics in speed control of motors.
- Understand and design single-phase half wave converter with SCR.
- Analyze and interpret results.
- Work with a digital oscilloscope to debug circuit and analyze signals.

Equipment:

To carry out this experiment, you will need:

- Half wave controlled Converter Power circuit kit
- SCR firing circuit kit, 1-phase, 230V, 5A
- Patch chords
- Load (100 ohm / 2A)
- Digital Oscilloscope (TBS1000B-EDU from Tektronix)

Circuit Diagram:

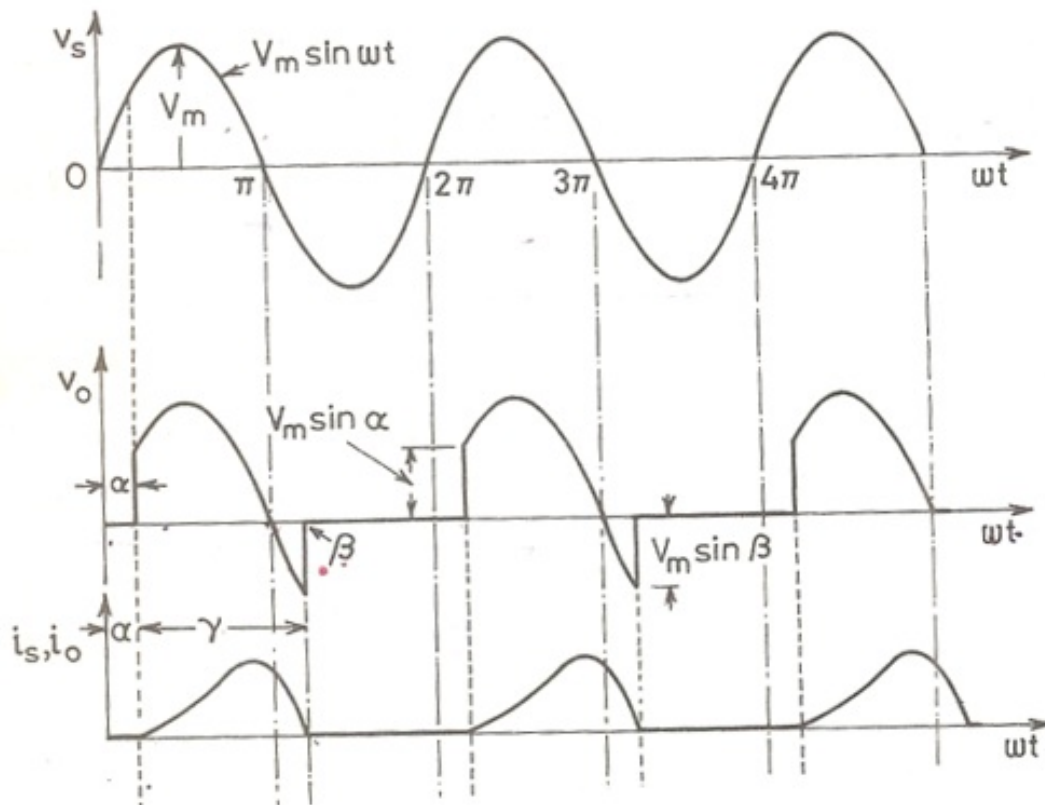


Theory:

- During first half of input application of gate pulse turns on thyristor when its anode is positive w.r.t. its cathode, and the forward voltage is greater than the threshold voltage. In this condition the voltage across the load is the same as the positive half cycle of the ac source.
- **During the interval 0 to $\pi/2$**
 - The source voltage V_s increases from zero to its positive maximum, while the voltage across the inductor V_L opposes the change of current through the load. It must be noted that the current through an inductor cannot change instantaneously; hence the current gradually increases until it reaches its maximum value.
 - The current does not reach its peak when the voltage is at its maximum, which is consistent with the fact that the current through an inductor lags the voltage across it. During this time, energy is transferred from the ac source and is stored in the magnetic field of the inductor.
- **For the interval $\pi/2$ and π**
 - The source voltage decreases from its positive maximum to zero. The induced voltage in the inductor reverses polarity and opposes the associated decrease in current, thereby aiding the SCR forward current.
 - Therefore, the current starts decreasing gradually at a delayed time, becoming zero when all the energy stored by then inductor is released to the circuit.
 - Again this is consistent with the fact that current lags voltage in an inductive circuit. Hence, even after the source voltage has dropped past zero volts, there is still load current, which exists a little more than half a cycle.
- **For the interval greater than π**
 - At π , the source voltage reverses and starts to increase to its negative maximum. However, the voltage induced across the inductor is still positive and will sustain forward conduction of the diode until this induced voltage decreases to zero.
 - When this induced voltage falls to zero, the thyristor will now be reversed biased, but would have conducted forward current for an angle β , where $\beta = \alpha + \gamma$.
- The average output voltage is given by:

$$V_0 = \frac{V_m}{2\pi} (\cos\alpha - \cos\beta)$$

- The ideal waveform of the experimental setup is shown in Figure below:



Acknowledgement:

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1Ph_HW_Converter_R-L_Load -- Procedures

Step 1

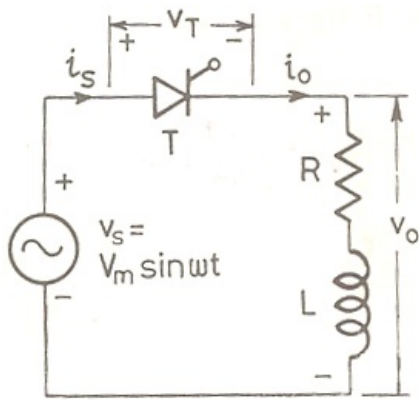
Precautions:

- A main switch should be included in whole circuit, so that in case of any emergency main supply can be disconnected from the circuit.
- Check all the connection before switching ON the power supply.
- Apply low voltages or low power to check the proper functionality of circuits.
- Load should be remained connected to the experimental setup for discharging the energy stored in the inductor or capacitor present in the circuit, if any.
- Don't touch live wires.

Step 2

Circuit Setup:

Build the circuit as shown below:



Step 3

Probe at Sine wave input (signal generator) source and across load resistance (V_o)

Step 4

Keep the multiplication factor of the CRO's probe at the maximum position (10X or 100X - whichever is available)

Step 5

Switch on the experimental kit and firing circuit kit.

Step 6

Set the firing angle to 0 degree and capture input and output waveforms on oscilloscope

Step 7

Measure the RMS value of the output and take screenshot of input and output waveform.

Step 8

Now change the firing angle to 30 degree.

Step 9

Measure the RMS value of the output and take screenshot of input and output waveform.

Step 10

Continue Step # 8 for different values of firing angle like 45, 60 and 90 degrees.

Step 11

Open Question:

- What will be RMS value when firing angle is 60 degree?
- How different this value is for circuit with just R load?

Step 12

Switch off the power supply and disconnect from the power source.