1Ph_HW_Converter_R-L-E_Load -- Overview

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

Objective:

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

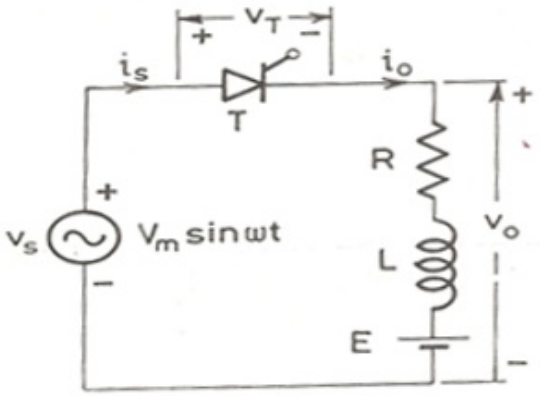
- Understand the working of 1-phase half wave control converter wit R-L-E load.
- Learn the role of Power Electronics in speed control of motors.
- Understand and design single-phase half wave converter with SCR.
- Analyze and interpret results.
- Work with a digital oscilloscope to debug circuit and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

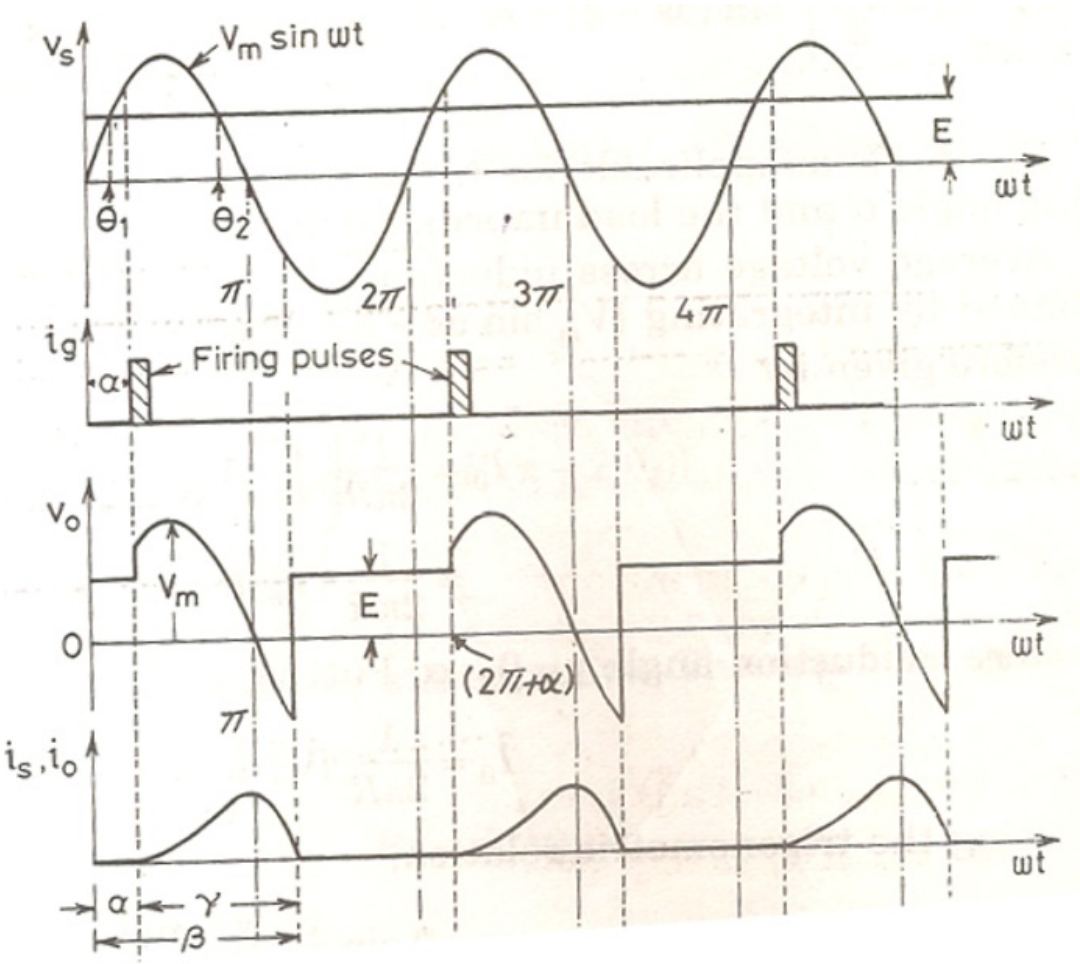
- The counter emf E in the load may be due to due to battery or a dc motor. The minimum value of firing angle is given by:

$$\alpha_{min} = sin^{-1}(\frac{E}{V_m})$$

- If thyristor is fired at an angle α < α_min then E>Vs, SCR is reverse biased and therefore it will not turn on. Similarly maximum value of firing angle is α_max = π - α_min.
- For ωt > π/2; 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 diode 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.
- 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 β = α + γ.
- The average output voltage is given by:

$$V_0 = \frac{1}{2\pi}\{V_m(cos\alpha - cos\beta) + E(2\pi + \alpha - \beta)\}$$

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



Acknowledgement:

Special thanks to Vikas Singh Bhadoria (Asst. Professor, Electrical Engineeering Department, JRE Group of Instiutions) for supporting the development of this lab courseware.

1Ph_HW_Converter_R-L-E_Load -- Procedures

Step 1

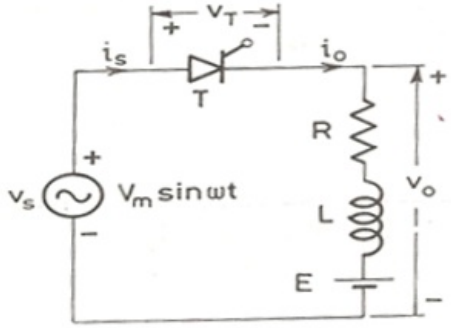
Precautions:

- 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_0)

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 is the difference in V_0 waveform shape and its RMS Value when compared with that of circuit having only R load?

Step 12

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