1Ph_FW_Converter_R-L_Load -- Overview

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

Objective:

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

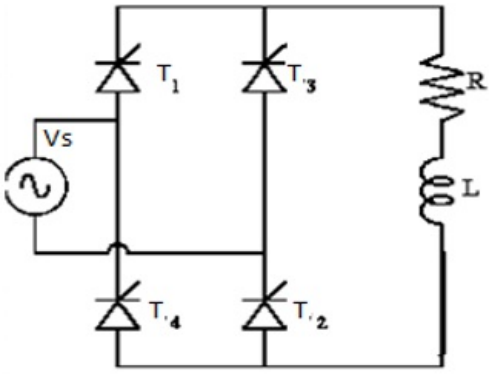
- Understand the working of 1-phase Full-Wave control converter wit R-L load.
- Learn the role of Power Electronics in speed control of motors.
- Understand and design single-phase full-wave converter with SCR.
- Analyze and interpret results.
- Work with a digital oscilloscope to debug circuit and analyze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

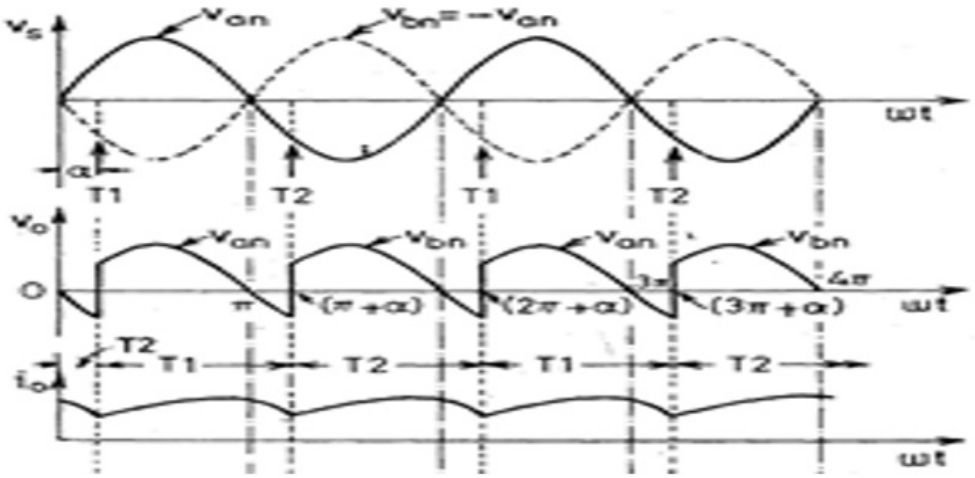
- The circuit has four SCRs. For this circuit, Vs is a sinusoidal voltage source. When it is positive, the SCRs T1 and T2 triggered then current flows from +ve point of voltage source, Vs

through SCR T1, load inductor L, load resistor R(from up to down), SCR T2 and back into the –ve point of voltage source.

- In the next half-cycle the current flows from –ve point of voltage source, Vs through SCR T3, load resistor R, load inductor L(from up to down), SCR T4 and back into the +ve point of voltage source.
- Even though the direction of current through the source alternates from one half-cycle to the other half-cycle, the current through the load remains unidirectional (from up to down).
- Let Vs = Vm sin ωt, with 0 < ωt< 360. If ωt= 30 degree, when T1 and T2 are triggered, then the firing angle is said to be 30 degree. In this instance the other pair is triggered when ωt= 210 degree.
- When Vs changes from a positive to a negative value, the current through the load does not fall to zero value at the instant ωt= π radians, since the load contains an inductor and the SCRs continue to conduct, with the inductor acting as a source.
- When the current through an inductor is falling, the voltage across it changes sign compared with the sign that occurs when its current is rising.
- When the current through the inductor is falling, its voltage is such that the inductor delivers power to the load resistor, feeds back some power to the AC source under certain conditions and keeps the SCRs in conduction forward-biased.
- If the firing angle is less than the load angle, the energy stored in the inductor is sufficient to maintain conduction till the next pair of SCRs is triggered. When the firing angle is greater than the load angle, the current through the load becomes zero and the conduction through the load becomes discontinuous.
- Usually the description of this circuit is based on the assumption that the load inductance is sufficiently large to keep the load current continuous and ripple-free.
- The average output voltage is given by:

$$V_0 = \frac{2V_m}{\pi} cos\alpha$$

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



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1Ph_FW_Converter_R-L_Load -- Procedures

Step 1

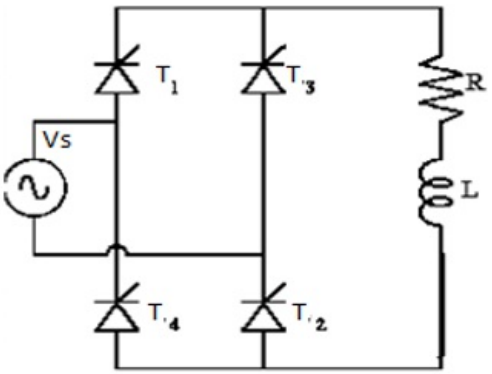
Precautions:

- 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_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 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.