1Ph_FW_Converter_R-L-E_Load -- Overview

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

Objective:

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

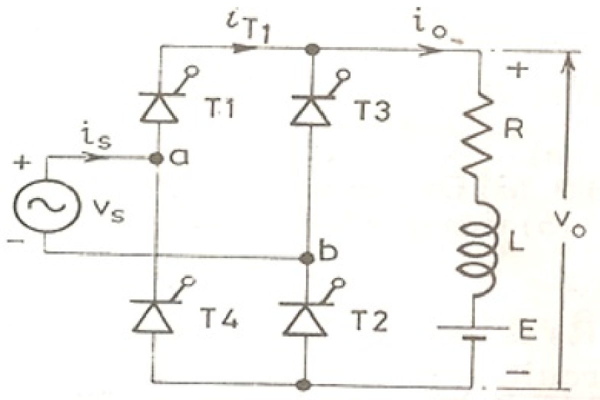
- Understand the working of 1-phase full-wave control converter wit R-L-E load.
- Learn the role of Power Electronics in speed control of motors.
- Understand and design single-phase full-wave converter with SCR.
- Analyze and interpret results.
- Work with a digital oscilloscope to debug circuit and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



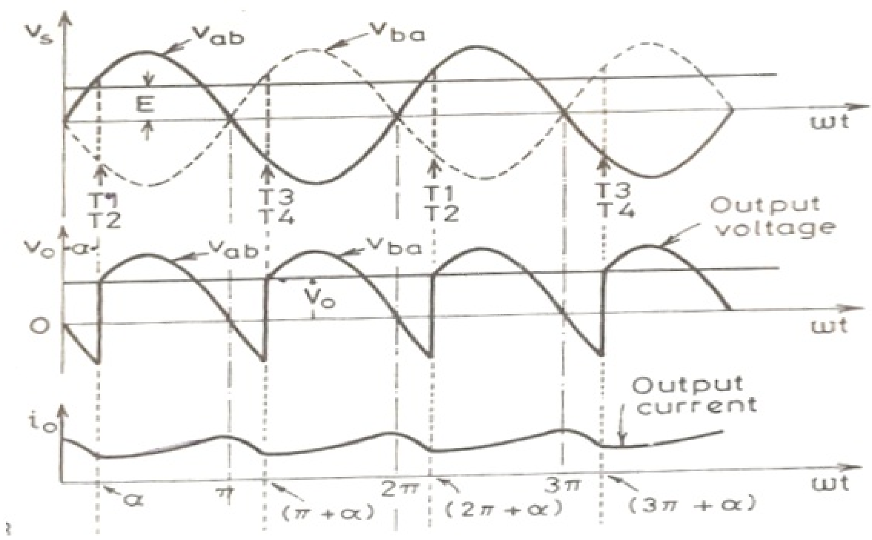
Theory:

- The circuit has four SCRs. For this circuit, Vs is a sinusoidal voltage source. The load is assumed to be of R-L-E type, where E is the load circuit EMF. This voltage may be a battery or may be the back emf of a DC motor.

- The SCRs T1 and T2 are simultaneously triggered and π radian later T3 and T4 are triggered together. When point a is positive w.r.t. b supply voltage is V_ab and when b is positive w.r.t. a supply voltage waveform is shown dotted as V_ba. Load current is assumed continuous over the range.
- Between ωt=0 and ωt=α; T1 and T2 are forward biased through already conducting SCRs T3 and T4 and block the forward voltage. For continuous conduction thyristors T3 and T4 conduct after ωt=0 eventhough these are reverse biased.
- Forward biased thyristors are triggered only when Vmsin ωt>E. When forward biased thyristors T1 and T2 are triggered at ωt=α, they get turned on.
- Hence supply voltage immediately appears across thyristors T3 and T4 as a reverse bias, therefore these are turned off by natural commutation. At the same time load current i_0 flowing in T3 and T4 is transferred to T1 and T2. T1 and T2 conducts for π radians i.e. from α to π+α. At ωt=π+α forward biased thyristors T3 and T4 are triggered.
- The supply voltage turns off T1 and T2 by natural commutation and the load current is transferred from T1 and T2 to T3 and T4.
- 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 (for α<90 degree):

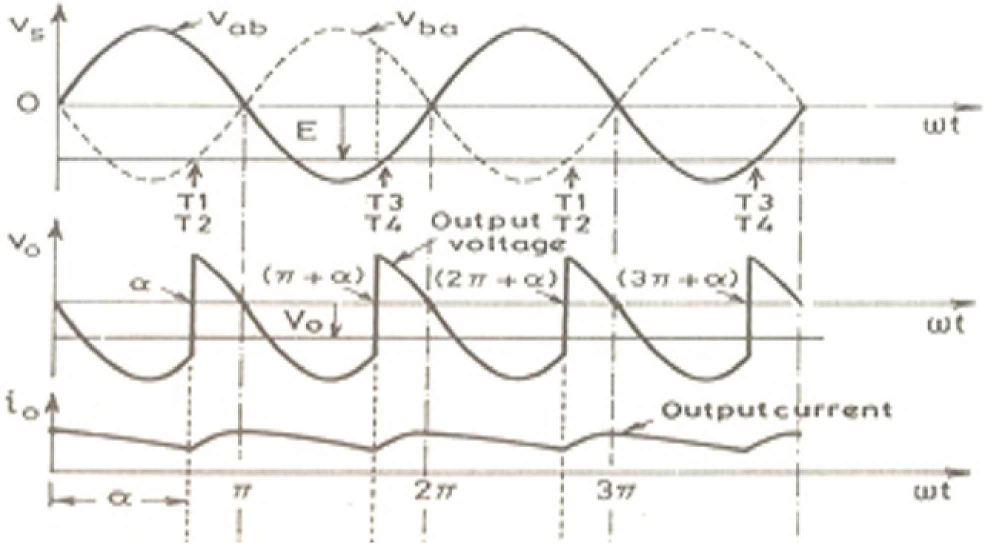


Inverter Mode:

- Inverter mode of operation if α>90 degree, output voltage is negative in this case. If the load circuit emf E is reversed and with α>90; then this dc source E will feed power back to ac source.
- This mode of operation of a full converter with α>90 degree is known as inverter operation and this full converter is known as

line commutated inverter.

- During 0 to α, ac source voltage is positive but ac source current is negative, power therefore flows from dc source to ac source.
- From α to π both ac source voltage and ac source current are positive hence power flows from ac source to dc source. But the net power flow is from dc source to ac source, because (π-α)< α.
- The ideal waveform of the experimental setup is shown in Figure below (for α > 90 degree):



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_FW_Converter_R-L-E_Load -- Procedures

Step 1

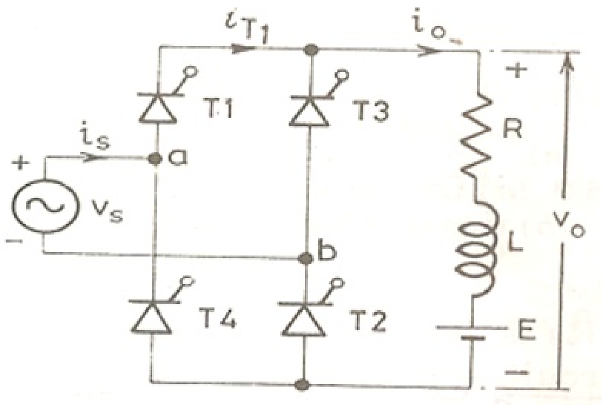
Precautions:

- 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.