3Ph_FW_Converter_R-L-E_Load -- Overview

Dr. Ashish Shrivastava (Professor & HoD)
Vikash Singh Bhadoria (Asst. Professor)
Electrical Engineering Department
JRE Group of Instiution, Noida (UP)

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

Objective:

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

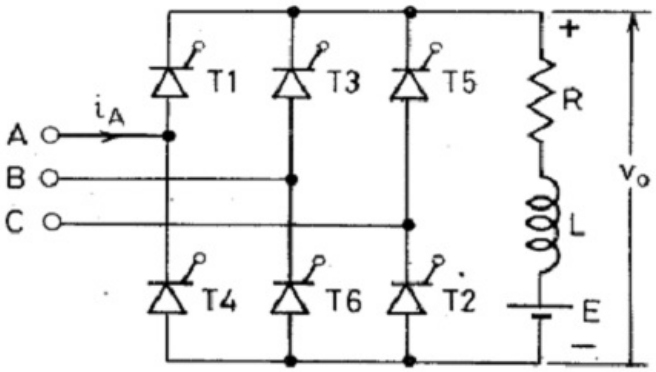
- Understand the concept of Line and Phase voltage in three phase circuit
- Understand the working of 3-phase full wave control converter wit R-L-E load.
- Learn the role of Power Electronics in speed control of induction motors.
- Understand and design three-phase full wave converter with SCR.
- Work with a digital oscilloscope to debug circuit and analyze signals.

Equipment:

To carry out this experiment, you will need:

- Three-phase full wave controlled Converter Power circuit kit
- SCR firing circuit kit, 3-phase, 230V, 10A
- Patch chords
- Load (100 ohm /10A)
- Digital Oscilloscope (TBS1000B-EDU from Tektronix)

Circuit Diagram:



Theory:

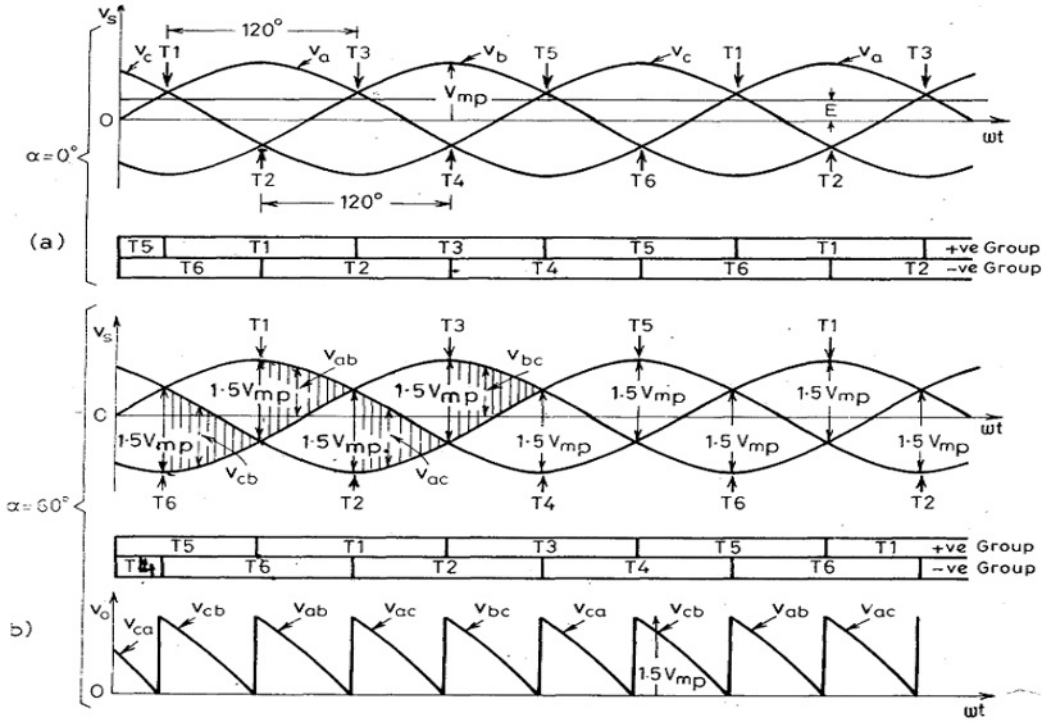
- Three phase input supply is connected to terminals A,B and C

and the load R-L-E is connected across the output terminals. The counter emf E in the load may be due to due to battery or a dc motor. Thyristors 1,3,5 are the positive group thyristors and 2,4,6 are the negative group thyristors.

- For α =0 degree; T1,T2,……T6 behave like diodes. For α =0 degree, T1 is triggered at ωt=π/6, T2 at 90 degree, T3 at 150 degree and so on. For α =60 degree, T1 is triggered at ωt=30 + 60=90 degree, T2 at 90 + 60=150 degree and so on.
- Each SCR conducts for 120 degree, when T1 is triggered, reverse biased thyristor T5 is turned off and T1 is urned on.T6 is already conducting. As T1 is connected to A and T6 to B, voltage Vab, appears across load. When T2 is turned on, T6 is commutated from the negative group.T1 is already conducting.
- As T1 and T2 are connected to A and C respectively, voltage Vac appears across load. Value of Vab and Vac varies from 1.5Vmp to zero. Vmp is the maximum value of phase voltage. This sequence of triggering is continued for other SCRs.
- Similar to positive group SCRs negative group SCRs are also fired at an interval of 120 degree. At any time, two SCRs, one from positive group and one from negative group, must conduct together for the source to energise the load. For ABC phase sequence of the three phase supply, thyristors conduct in pairs; T1 and T2, T2 and T3, T3 and T4, T4 and T5 and so on.
- Just like single phase converter for 0 <α ≤ 90 degree circuit works as three phase ac to dc converter and for 90 < α < 180 degre it works as a line commutated inverter.
- It can work in inverter mode only if the load has a direct emf E due to a battery or a dc motor. It should be noted that direction of current for both converter and inverter operation remains fixed but the polarity of output voltage reverses.
- Output voltage of the three phase full converter is given by:

$$V_0 = \frac{3V_{ml}}{\pi} cos\alpha$$ where V_ml is Maximum line voltage

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



3Ph_FW_Converter_R-L-E_Load -- Procedures

Step 1

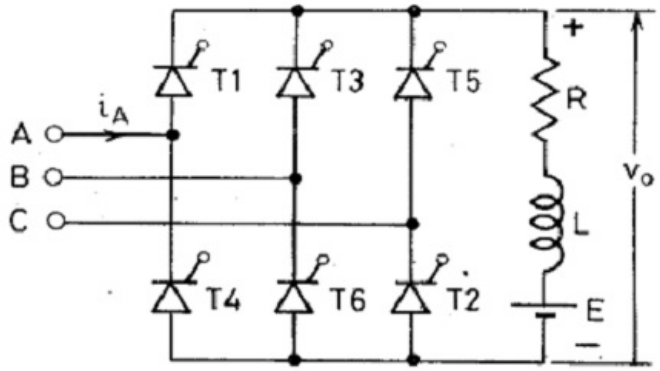
Precautions:

- 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 1 phase circuit with similar load?

Step 12

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