Power electronics project

Full-wave, fully-controlled, single-phase rectifier simulation

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Abstract

Power lines, transformers, and service lines are all designed to carry alternating current and voltage electricity (AC). A direct current and voltage (DC) is necessary for low-power devices used in houses, for example. This prompted the need for an intermediate device to convert incoming power from the line into a form that can be used by low-power electrical devices such as rectifiers. Rectification is the process of converting an oscillating sinusoidal AC voltage source into a DC voltage supply with a constant current. Diodes, thyristors, transistors, and converters can all be used to do this. Half-wave, full-wave, uncontrolled, and fully-controlled rectifiers can transform a single-phase or three-phase supply into a constant DC level. The full-wave, fully-controlled, single-phase rectifiers will be discussed in this study, along with a brief discussion of their method of operation, benefits, and probable applications. It also shows how the circuit works under different operating conditions.

1 Introduction

The full-wave rectifier generates a unidirectional output through using both halves of the input sinusoidal waveform. The single phase full-wave rectifier does this by employing four thyristors in a bridge configuration to pass the positive half of the sine wave while inverting the negative half to produce a pulsing DC output. The rectifier's output voltage and current pulsate, but they do not reverse direction using the entire input waveform. Thyristors in a bridge configuration offer full-wave rectification since two of the four thyristors are conducting at any given time, resulting in a closed loop for the current at any time interval.

2 Bridge Rectifier Circuit Operation

Two thyristors every half-cycle are used to control the average DC load voltage. During the positive half-cycle, thyristors **T1** and **T3** are fired together as a pair, while thyristors **T2** and **T4** are similarly fired together as a pair during the negative half-cycle, which is 180o after **T1** and **T3**.

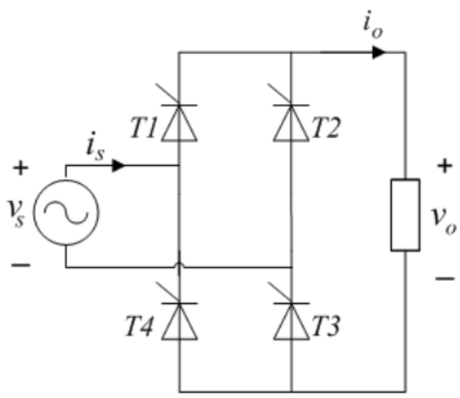

Figure 1: Full-wave rectifier

3 Advantages

In comparison to the half-wave rectifier, the full-wave bridge rectifier produces a higher mean DC value with less superimposed ripple since the output waveform is twice the frequency of the input supply.

4 Applications

Battery charging, DC motor powering, LED lighting, and radio signal modulation are some of the most popular uses for full-wave, fully-controlled single-phase rectifiers.

5 Simulation Results for R-Load

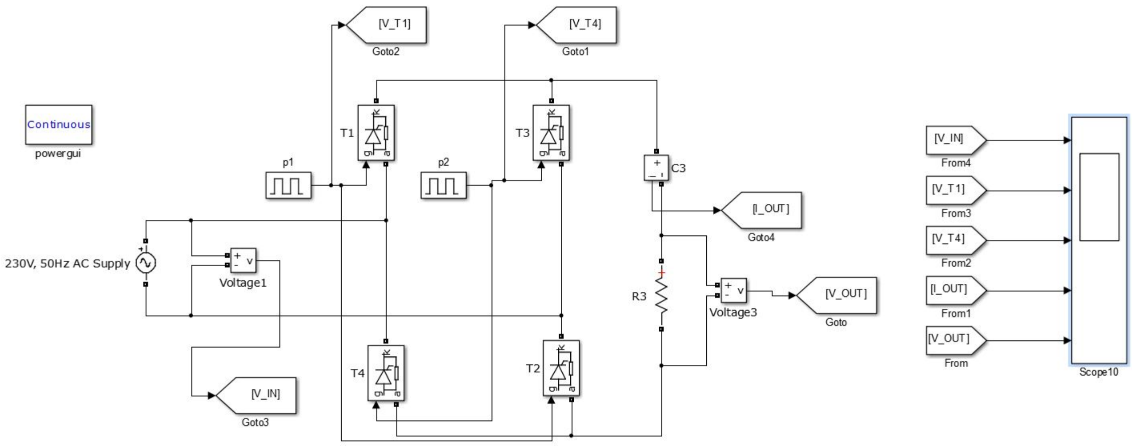

Figure 2: R-load full-wave rectifier circuit

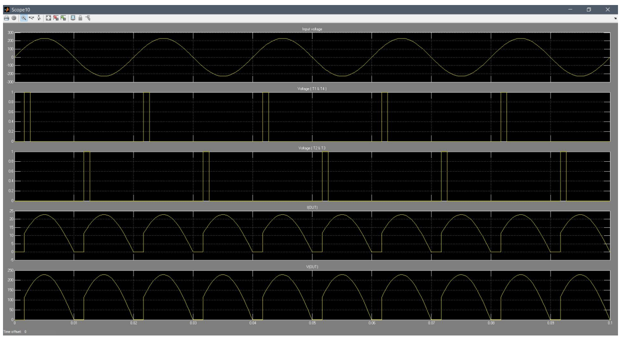

Figure 3: R-load full-wave rectifier simulation graphs

6 Simulation Results for RL-Load

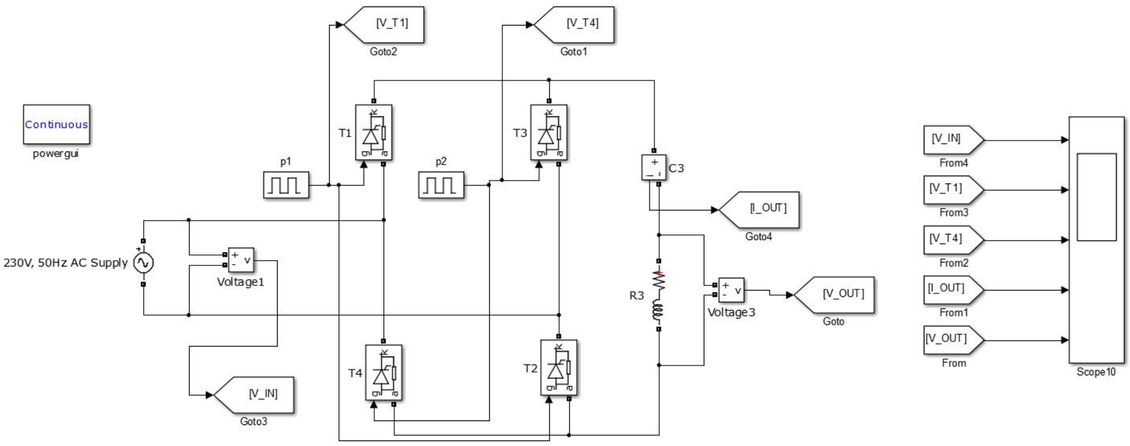

Figure 4: RL-load full-wave rectifier circuit

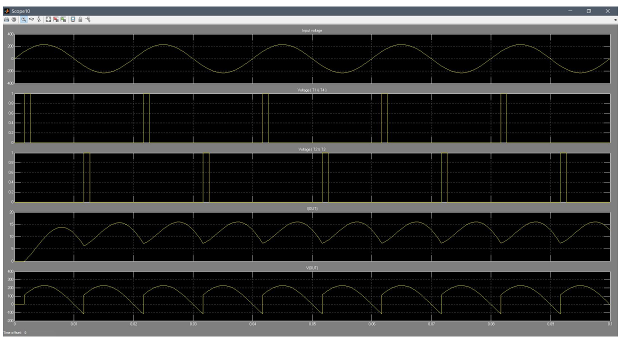

Figure 5: RL-load full-wave rectifier simulation graphs

As we see in the figure the RL-load affects on the output voltage and make it work in the intervals it reached zero before while using Resistive load.

7 Simulation Results for RL-Load with Free Wheeling Diode

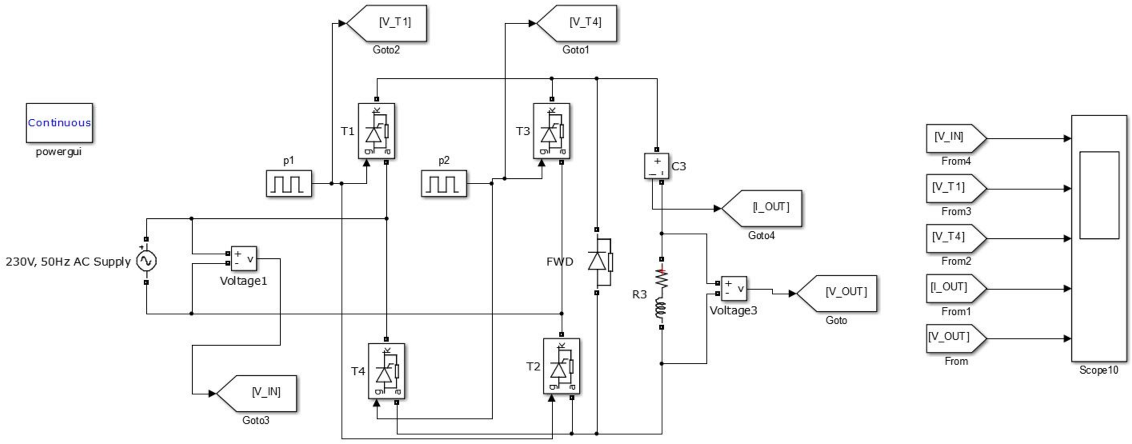

Figure 6: RL-load with Free Wheeling Diode full-wave rectifier circuit

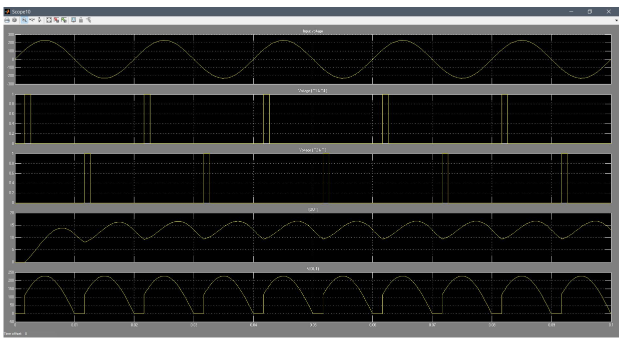

Figure 7: RL-load with Free Wheeling Diode full-wave rectifier simulation graphs

8 Conclusion and Recommendations

For all simulations carried out with a firing angle of (α = 60°). The output voltage (V_{out}) and output current (I_{out}) curves are plotted. For the R-Load with R=10 Ω, both V_{out} and I_{out} are positive, with I_{out}= V_{out} / R. For RL-Load, **T1 and T3** will operate from $\alpha \rightarrow \beta$ and **T2 and T4** will operate from $\pi+\alpha \rightarrow \pi+\beta$. For RL-Load with a FWD, the FWD will clip the negative part of the output voltage (V_{out}).

References

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