

ENG306

Power Electronics

Lab 2

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1 Introduction

2 Diode Rectifiers

2.1 Half-Wave Rectifier with Resistive Load

Plot (using data saved from the oscilloscope) or insert screenshots or sketch by hand, waveforms for v_s , v_o , i_o and v_D using the same time-scale x axis (so that they can be easily compared – including diode voltage), and discuss your observations briefly.

From your waveform measurements using oscilloscope, compare the dc output current and voltage against digital multimeter measurements and also against values determined by applying theoretical relationships for this rectifier. Present the different measurements and calculated values in table form, commenting on your observations.

2.2 Full-Wave Rectifier with Resistive and Inductive Load

Why was it necessary to measure the rectifier supply voltage waveform using the oscilloscope probes on the second of the two secondary windings or using two probes and the maths function? Describe what you think would happen if probes were still placed across the first winding (i.e. between points 1 and 2 on the circuit).

For the resistive load only set up, plot (using data saved from the oscilloscope) or insert screenshots or sketch by hand, waveforms for v_s , v_o , i_o using the same time-scale x axis, and discuss your observations.

Again for the resistive load only, from your waveform measurements using oscilloscope, compare the dc output current and voltage against digital multimeter measurements and also against values determined by applying theoretical relationships for this rectifier. Present the different measurements and calculated values in table form, commenting on your observations.

For the resistive and inductive load, plot (using data saved from the oscilloscope) or insert screenshots or sketch by hand, waveforms for v_s , v_o , i_o and v_D for the two diodes measured, using the same time-scale x axis (so that they can be easily compared – including diode voltage), and discuss your observations, including comparing against what was observed for resistive only load

Present your measured average (dc) and rms values of output voltage and current (for RL load). How do they compare to the values measured for the resistive load only and why?

By considering losses in the four diodes, estimate your overall rectifier circuit efficiency. Note: there are a few approaches you can take here, some which may require you to think about and perform some more measurements in the lab.

2.3 Full-Wave Rectifier with Capacitive Output Filter and Resistive Load

Tabulate, to allow for easy comparison, your measured dc output voltage and peak-to-peak ripple for each of the three capacitors values

Carefully plot (using data saved from the oscilloscope) or sketch by hand on one graph the output voltage waveform observed for each of the three capacitor values. Comment on how and why the waveforms and measurements differ with changing capacitor value.

Develop an approximate expression for percentage peak-to-peak ripple as a function of R , C and frequency f , stating carefully any assumptions. How do your calculated values, using your derived expression, compare to your measurements?

How would you expect the value of the capacitor to impact upon supply current waveform, in particular on the harmonic content? Describe why you expect this? (Note: if you have time you may wish to think of a way to measure and display the Fourier components of supply current for your circuit, thus gaining extra insight)

3 Thyristor Controller Rectifiers

3.1 Semi-Converter with Resistive and Inductive Load

Firing angle	Digital multimeter		Calculated
α	V_o	I_o	V_o
0	0	0	
20	0.8	0.8	
45	3.4	20	
60	5.6	63	
90	9.7	159	
100	10.2	184	
120	10.9	247	
140	10.6	285	
160	9.5	317	
180	8.8	333	

Detail the way you connected your oscilloscope probes and configured the oscilloscope to record simultaneously the source voltage, trigger signal, output voltage and current waveforms.

The common ground is at $+V_o$ to allow for common measurements. Channel 1 measures the source voltage using the secondary transformer winding. This is acceptable as it is electrically isolated from the remainder of the circuit so multiple grounds cannot cause a short circuit. Channel 2 measure the output voltage, with its positive probe placed at $-V_o$. Channel 3 measures I_o , with its probe placed between the 1Ω and 47Ω resistors. Measuring the voltage over the 1Ω resistor is equivalent to measuring current as $V = IR$. Channel 4 measures the positive trigger input of T_1 .

Include plot from oscilloscope of all waveforms for a firing angle of 45° .

TODO: Add plot.

Comment on the observed waveforms and on how they changed with firing angle, describing your observations by considering theory of the circuit operation.

From your measured data, create a plot of dc output voltage vs firing angle. Also include in the plot a curve based on theoretical considerations for this circuit. Discuss your findings

Based on your observation, at what firing angle did you observe there to first be a boundary between continuous and discontinuous conduction (of current in the load). Compare to what you might expect from a theoretical view point?

Describe the purpose of the freewheeling diode in this circuit and what you think might happen if it were removed.

4 Reflection

End of Report