TÉCNICO LISBOA

Circuit Theory and Electronics Fundamentals

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RC circuit

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Contents

1 Introduction

The objective of this laboratory assignment is to build an AC/DC converter, with a transformer, envelope detector and voltage regulator. The AC voltage of 230V and frequency 50Hz will be transformed into a DC voltage of 12V.

In Section 2, a theoretical analysis of the circuit is presented. In Section 3, the circuit is analysed by simulation, and the results are compared to the theoretical results obtained in Section 2. The conclusions of this study are outlined in Section 4.

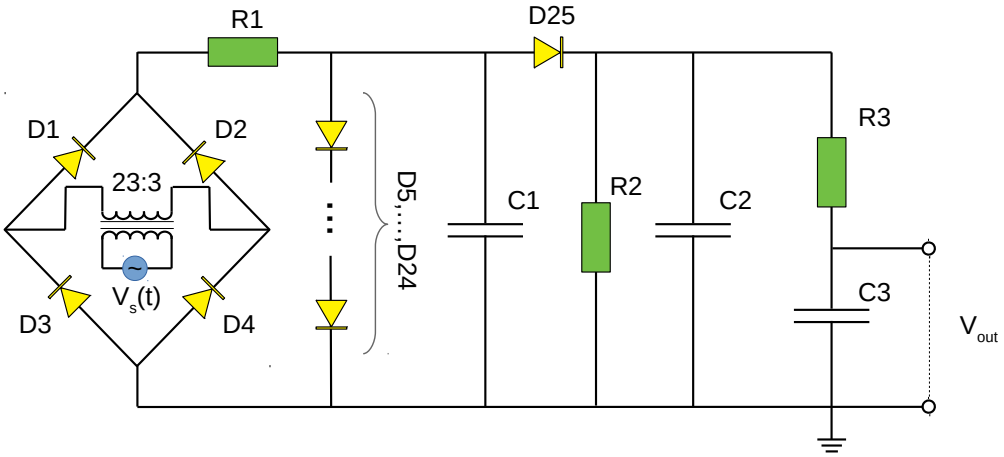


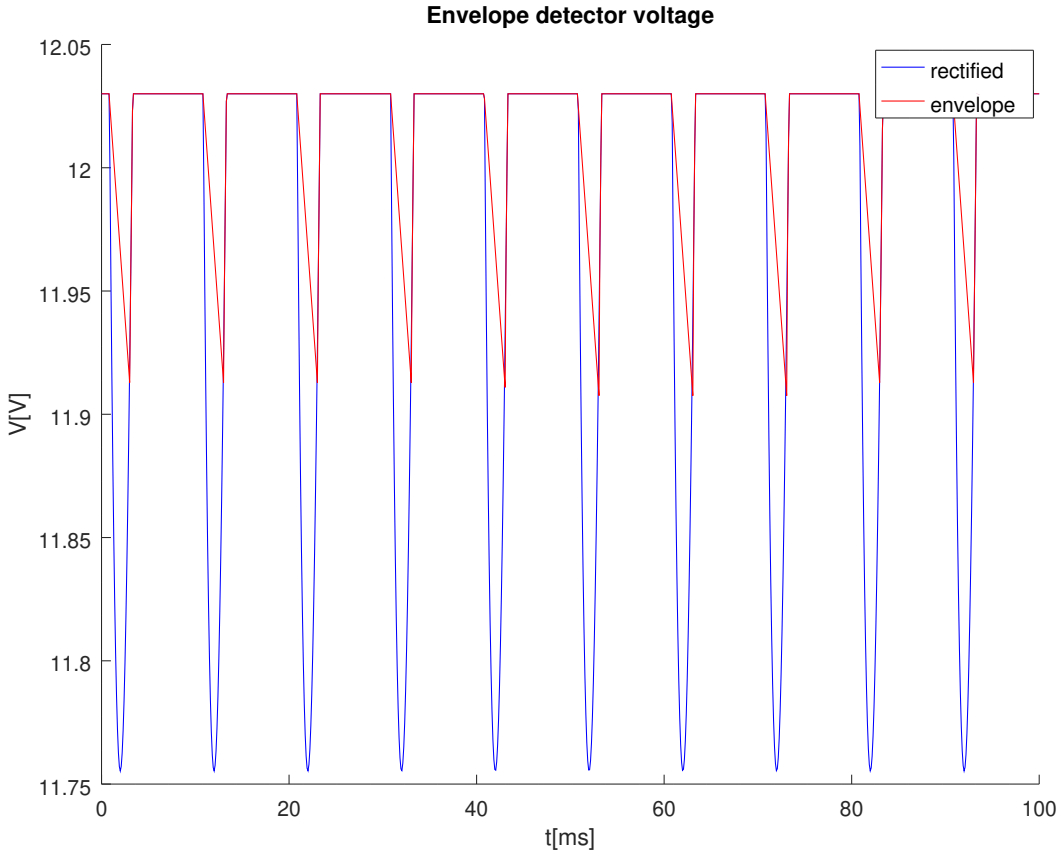
Figure 1: AC/DC Converter

2 Theoretical Analysis

For the theoretical simulation, we used the ideal diode model for the full-wave bridge rectifier, obtaining the absolute value of the initial signal.

For the limiter circuit associated with a first-order low-pass filter, we performed fourier analysis on the previously obtained signal, in order to use phasors to solve for the voltage on the capacitor. The vON diode model was used in this stage, such that any voltage above n*vON (n be-

ing the number of diodes in this part of the circuit) was limited. This is visualised in the below fig-

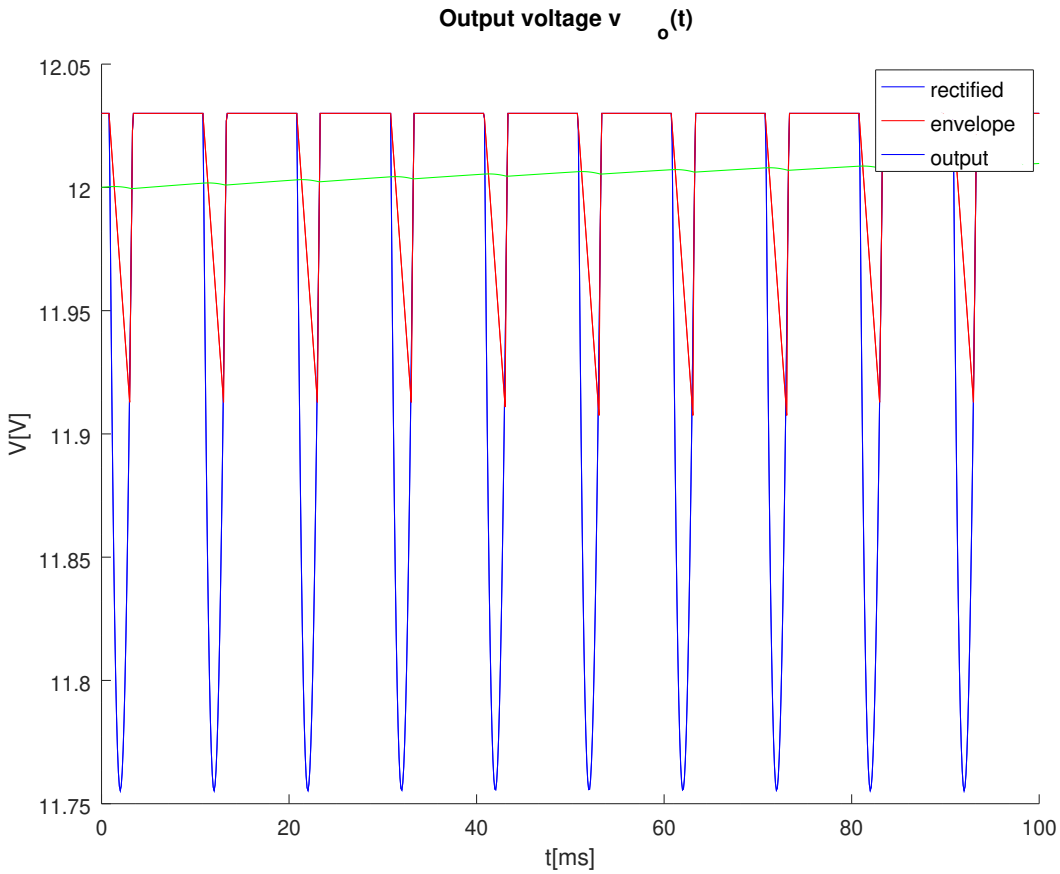


ure:

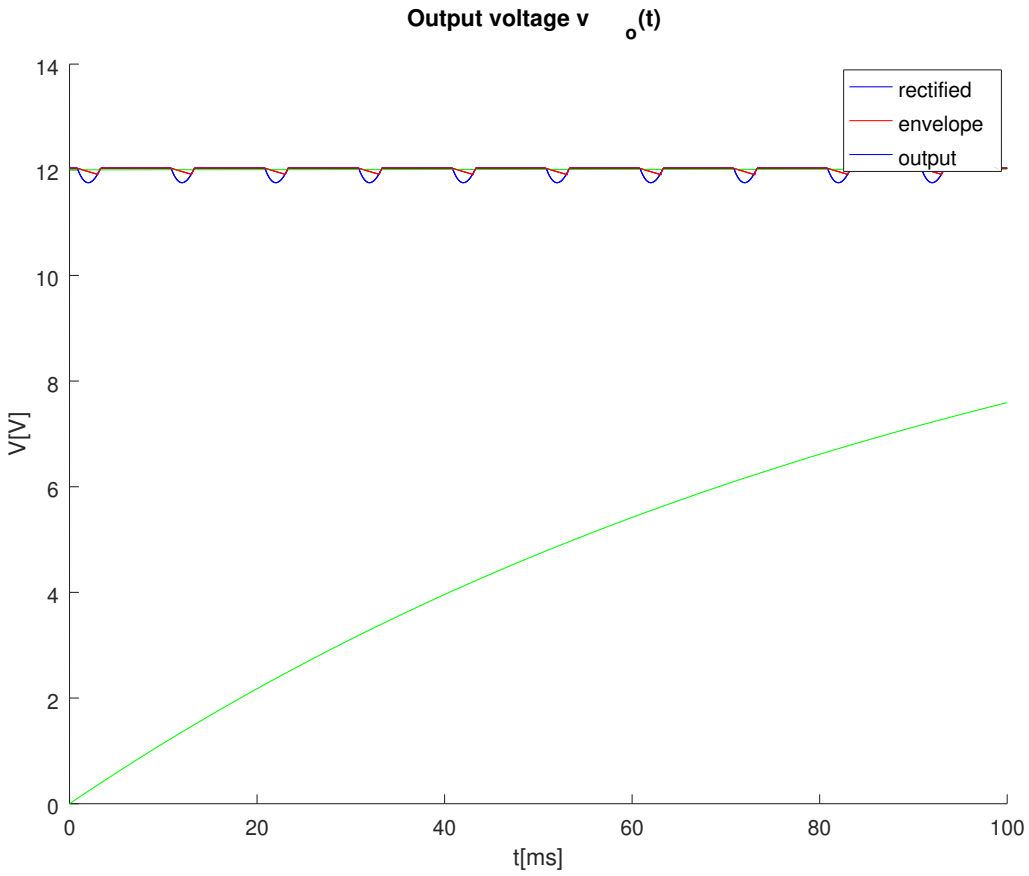
The envelope detector was analysed with the tOFF method, with its value being determined by the below equation:

$$\frac{dVs}{dt} = -\frac{Vs}{RC} \tag{1}$$

After time tOFF the output voltage of this part of the circuit was modeled using an exponecial, until it crossed the input voltage once more. We see this effect below:



For the low-pass filter at the end, we used the Euler method to solve the differencial equation for an RC circuit, thus obtaining the final output voltage:



2.1 Envelope detector

2.2 Voltage regulator

3 Simulation Analysis

3.1 Transient analysis

We simulated the circuit using transient analysis, using a non ideal transformer and the following components:

Table 1: Valores de I e V para cada ensaio

$V_{fonte}(V)$	$I(A)$	$V_{detetor}(mV)$
C1	$3.7224F$	
R1	$3.7224k$	
C2	$15F$	
R2	$15k$	
C3	$10F$	
R3	$10k$	

Firstly we simulate the initialization of the circuit, and only once it has stabelized do we take the average and ripple of V_{out}. $Plotingthepotentialafterthe rectifier, theenvelopeandthe V_{out} forthefirst 2secon$

As we can observe, the stabilization time for $V_{out} isapproximatly 0.6seconds, butthestart-upsequencealwayshasalowervoltagethanthedesiredoutput, soitdoesn't poseathreattodamagethecircuitconnect$

By choosing a 10 period section in which the circuit has already stabelized, we can better study it.

The average of $V_{out} in equilibrium is 12.000000 V and the ripple is 4.13 mV. The circuit costs 59.9448 monetary un$

4 Conclusion

In this laboratory assignment the objective of building an AC/DC converter circuit by using a tranformer, envelope detetcor and a low-pass filter was achieved. The ripple The estabilization time The merit

The results from both the theoretical analysis using octave and the circuit simulation using ngspice appear to match.