

# MATLAB Optimization of Boost DC-DC Converter

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**Abstract**—In the current paper a MATLAB optimization of a boost DC-DC converter is presented. With the aid of the mathematical model created by the methodology of switching function is executed an optimization procedure with main purpose precise definition of the designed value of the passive components. The purpose of this research is to obtain aperiodic transient process in the output of the converter. This facilitates control synthesis and facilitates the setting of the controller coefficients. The specific implementation was done with the help of tools that are created in the MATLAB/Simulink environment, which is very useful in view of the use of the proposed procedure by non-specialists in mathematics. On the other hand, as a result of the optimization, the transient time in the power circuit is shortened, which significantly improves its dynamics.

**Keywords**—boost DC-DC converter, mathematical modelling, optimization

## I. INTRODUCTION

The power electronic converters are becoming increasingly popular in a view of the growing demands for efficient use of electricity and their assuring. The DC voltage pulse converters are electronic converters that convert (regulate) DC input voltage to DC voltage of the output with another value. It is known that stabilizers with continuous late action, especially at higher powers, have low efficiency (less than 50%). With pulse converters permanently tension avoids this serious drawback. It exist many methodology for designing DC-DC converters. Their basic characteristic is that they are based on the use of analysis in a steady state operation, ignoring the transients process. This facilitates the analysis and the calculation procedures created on their basis, but the obtained values of the circuit components are not precise and do not reflect the dynamics of the electronic converters. On the other hand, with the development of microelectronics, methods for controlling power electronic converters are becoming increasingly popular - mostly digital, which are based on complex computational procedures and as a result of their use, the performance of devices is improving. The combination of modern means of computational mathematics with the capabilities of modern microcontrollers makes it possible to obtain power electronic converters with very good performance and price indicators. This is the purpose of power electronics specialists - with the combination of classic and innovative design methods to improve and guarantee the performance of this type of devices and systems.

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## II. MATHEMATICAL MODELLING

### A. Principe of operation

The principle of operation of the converter in set mode includes two main states of the circuit: when the transistor is open and when the transistor is blocked. When the transistor is turn off it flows through the coil linearly increasing current. The increase of this current (the slope of lines) is determined by the supply voltage, which is applied to the coil, the value of its inductance  $L$  and the time during which the transistor is turned off. Flowing through the current coil determines the energy accumulated in it. When opening switch  $T$  (transistor blockage), the energy stored in the coil is transmitted to the load through diode  $D$ . In figure 1 is presented the scheme of the boost converter.

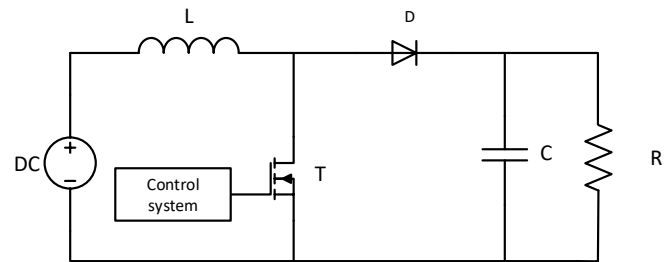


Fig. 1. Scheme of the boost converter

The interval during which the transistor is on for  $t = t_{ON}$ . For the voltage on the coil and the current through the capacitor at open transistor ( $t = t_{ON}$ ) can be written:

$$u_L = U_{in} \quad (1)$$

$$i_C = -\frac{U_{out}}{R} \quad (2)$$

Interval during which the transistor is turn off, for  $t = t_{OFF}$ . For the voltage on the coil and the current through the capacitor for this time interval ( $t = t_{OFF}$ ) can be written:

$$u_L = U_{in} - U_{out} \quad (3)$$

$$i_C = i_L - \frac{U_{out}}{R} \quad (4)$$

In Figure 2 is realized the mathematical model of the boost converter in MATLAB/Simulink with the aid of the described equations. This model will be used to optimize the values of the DC-DC converter elements.

In this research is used a boost converter with the following parameters presented in Table 1.

TABLE I. TABLE TYPE STYLES

Input data		
Input voltage	3	[V]
Inductance	882	[ $\mu$ H]
Capacitance	50	[ $\mu$ F]
Load	16	[ $\Omega$ ]
Frequency	100	[kHz]

This parameters are obtained by the classical design of the boost converter which is presented in the literature [8]

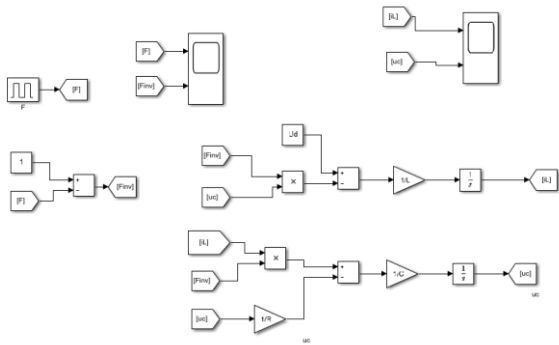


Fig. 2. MATLAB model of a boost converter

### III. SIMULATION RESULTS

The simulation results from the developed model are presented in Figure 3. The first curve is the current through the inductor L and the second curve is the output voltage. It can be observed that the over-regulation is around 50 % of the established value of the current. Similarly the time for establishing the transient process is 6 ms.

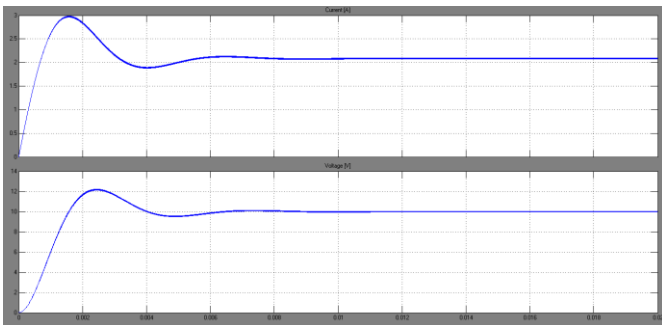


Fig. 3. Current and Output voltage

#### A. Optimization

At this section, the topology of a boost DC-DC converter is presented. Based on the mathematical model of the DC-DC converter, an optimization procedure implemented in MATLAB / Simulink is used to determine the value of the elements. This solution also contributes to determining the controller ratio, which in different cases can be very complex.

For avoiding additional devices and system for "soft it will be formulate an optimization problem. Limiting the

starting current in the load by optimizing the selection of L and C at the same time preventing large fluctuations of the load voltage in the set mode.

With MATLAB numerical optimization is done for the elements L and C. The initial values of these elements are selected after standard design and then adjusted with numerical optimization.

The mathematical model described by equations was developed in the MATLAB/Simulink programming environment using the F and  $F_{inv}$  switching functions. Figure 4 shows the mathematical model implemented in MATLAB/Simulink. For optimization of this mathematical model, it is used a tool "Constraint" provided by MATLAB / Simulink environment. With its help can be applied a procedure for optimization with the implemented methodologies. The basic idea is to add a limits of the output curve of the current and the voltage and thus to restrict the values of the passive components L and C.

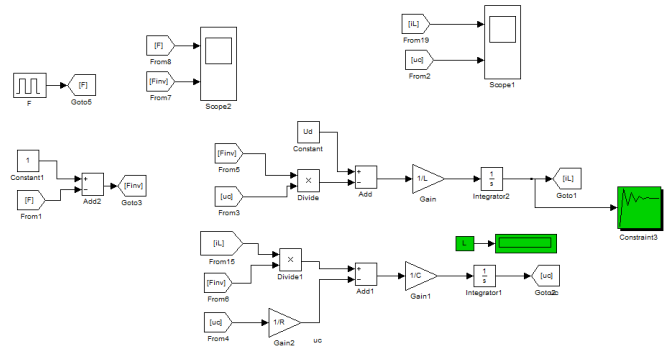


Fig. 4. MATLAB model of a boost converter with optimization

The results of the numerical optimization are presented in Figure 4. It can be observed the new values of the components in the scheme.

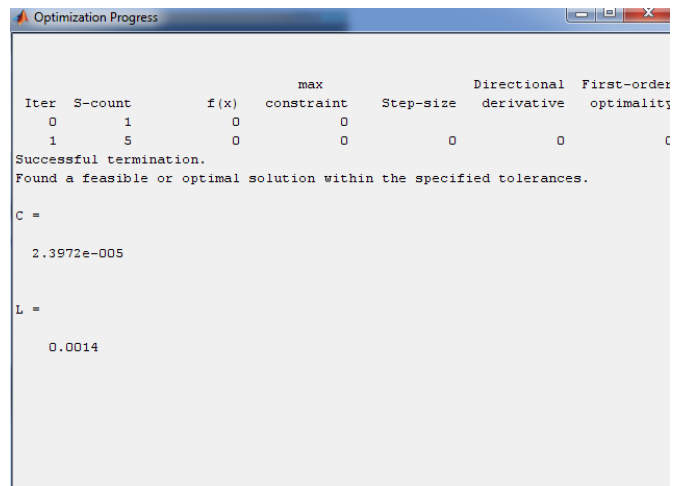


Fig. 5. Numerical results in MATLAB

Figure 5 shows simulations with the optimized values of the passive components in the circuit. The first curve is the current through inductor L, the second is the voltage of the capacitor C. It can be noted that the transition process is significantly reduced.

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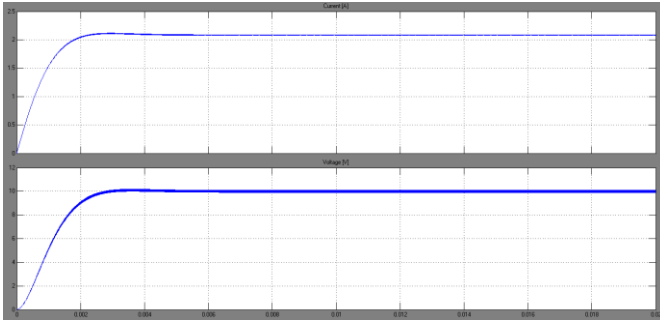


Fig. 6. Current and output voltage after optimization

## IV. CONCLUSION

In the current research a model of a boost DC-DC converter in MATLAB/Simulink is proposed. For description of the model are used the differential equations. With their help an optimization with different values of the passive components was realized. It can be observed that there is a significant decreasing of the time for establishing the transient process. The main purpose of this study is to adjust the dynamic process of the different systems, which can allow optimization of the value of electronic components such as capacitors and inductors. This solution is easily for usage by students, young researcher and phd students and also can be used for multiple DC-DC converters for optimization of the elements and improvement of the characteristics of the converters.

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