THE DEVELOPMENT OF AN ANDROID APP AS A TOOL FOR LEARNING AND DESIGNING DCDC CONVERTERS

Leonardo Acosta Rodrigues [1]

Natalia Braun Chagas [2]

Resumo:

This paper presents the development of an Android app for the DC-DC Buck, Boost and Buck-Boost converters project. The application consists of three main strands. The first is followed by presenting the design components of one of the converters, where the input data are referenced to the percentage change in current in the inductor and voltage in the capacitor, while the second base in the value of the components, in order to obtain the opposite. In addition, it is also possible to obtain the values of Snubber design components and the complete E-Core inductor design, which uses a looped programmed design method to choose the best possible component for the selected converter. Finally, in the third strand is the learning space of the application, where a flap will be developed for information on the operation of the converters, seeking to facilitate the understanding of the area in the power electronics.

Palavras-chave: Android, DC-DC converters, power electronics, Snubber design, E-Core inductor

Modalidade de Participação: Iniciação Científica

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[1] Aluno de graduação. leonardoactrodrigues@gmail.com. Autor principal

[2] Docente. natalia.b.chagas@gmail.com. Orientador

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1 INTRODUCTION

The use of wireless technology allows learners to have access to information and learning material no matter the place or the moment. For this reason, wireless technology has given learners full control over when and where they want to learn (ALLY, 2009; KEARNEY et al., 2012)

Most of the learning objects are implemented in traditional platforms as desktop computers or laptops. Today, mobile devices (smartphones and tablets) are being improved at a hardware and software level with relatively low costs. For this reason, the development of tools that support the learning process focuses on these mobile devices can be considered worthwhile (ARISTIZABAL; ALMARIO; LOPEZ, 2014).

The development of the proposed app rises as a strategy for reducing the complexity in order to obtain accurate calculations to design DC-DC converters, such as the Buck, Boost and Buck-Boost converters. Thus, providing easy access to full development within minutes of use.

Beyond that, this app also presents a special activity for the advanced results of the project. It provides information about the value of critical inductance to achieve the continuous conduction mode, the project of Snubber and the full design of an E-Core inductor.

Finally, the software also facilitates understanding the subject for new students in the power electronics area, containing all the main concepts of the object of study.

2 METHODOLOGY

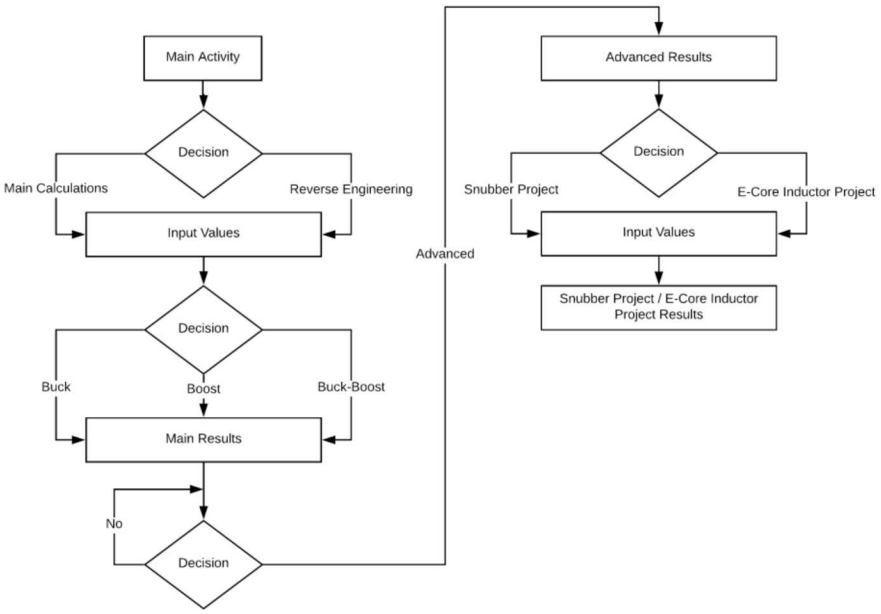
This app was developed using the software development environment Android Studio for Google's Android operating system, built based on the Java programming language, with the help of Corel Draw software to create the figures present in the activities. In addition, the Matlab software was also used to create the code routine for the E-Core inductor design. In order to construct the graphs present in the information activity, the LTspice software was used. Figure 1 presents a flow chart of the implemented app.

For the development of the Main Calculations, it was used as input the following parameters: Input Voltage (V), Output Voltage (V), Power Output (W), Ripple Inductor Current (%), Ripple Capacitor Voltage (%), Efficiency (%) and finally the Frequency (kHz), for the operation of the PWM (Pulse-Width Modulation). In order to obtain the results, access to the Reverse Engineering and Information, was used virtual buttons.

If the user has access to the converter's components values and wants to know its output power, for example, one can use the "reverse engineering" activity. The following input variable are requested: Input Voltage (V), Output Voltage (V), Inductance (mH), Capacitance (uF), Resistance (Load) (Ohms) and Frequency (kHz). The selection buttons were implemented in the same way of the main section. The values used are the same of the main section for the Boost converter project.

A "Definitions" page as also added to the app. In these sections, all information of the study object will be presented. It will contain explanations for each step of the project developed, detailing the operation of the converters, Snubber and considerations for the E-Core inductor design. Besides that, also it was added a sub activity "Symbols" to describe each symbol used during the steps of the app.

Figure 1 – Main Calculations



Source: Author, 2018.

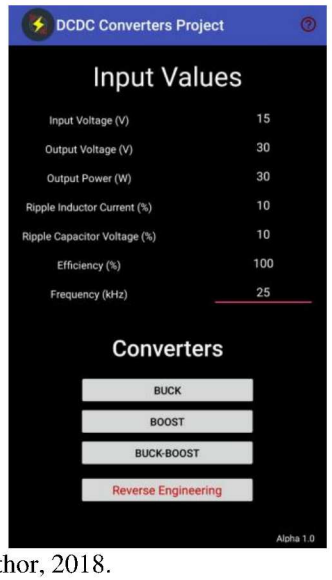
3 RESULTS AND DISCUSSION

The app is used, in this example, to design a Boost converter and all the app pages are here depictured and discussed.

3.1 Main Calculations

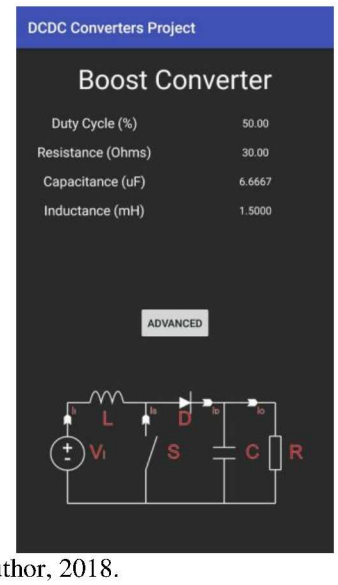
Figure 2 presents the mentioned parameters in the main activity of the app, and the converter is chosen at this page as well. Figure 3 presents the results obtained for the Duty Cycle, Capacitance and Inductance. Furthermore, the schematic of the converter to be designed is also presented.

Figure 2 – Main Calculations



Source: Author, 2018.

Figure 3 – Main results – Output variables

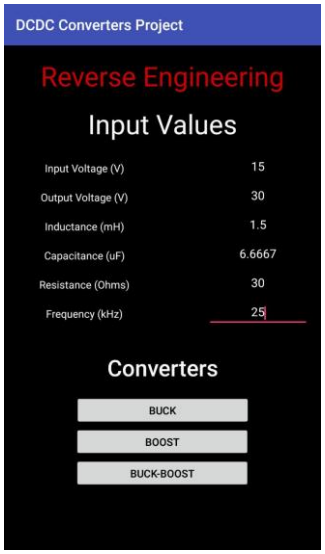


Source: Author, 2018.

3.2 Reverse Engineering

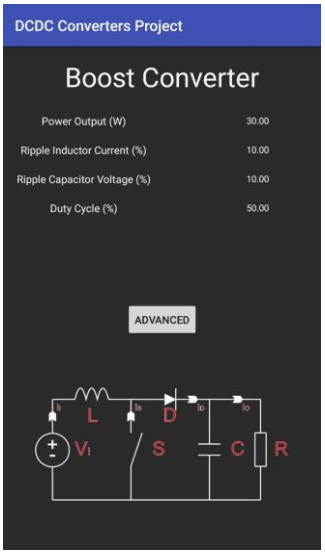
The “Reverse Engineering” section is demonstrated at the Figure 4. From the selected “Reverse Engineering” button at the main activity, the next page is shown by Figure 5. The results obtained are Power Output (W), Ripple Inductor Current (%), Ripple Capacitor Voltage (%) and Duty Cycle (%).

Figure 4 – Reverse Engineering



Source: Author, 2018.

Figure 5 – Reverse Engineering results



Source: Author, 2018.

3.3 Definitions

Figure 6 illustrates this section, demonstrating how it will be the explanation of the Buck converter. Beyond that, Figure 7 demonstrates the activity "Symbols" which demonstrates all the symbols used in the figures present in the application.

3.4 Advanced Calculations

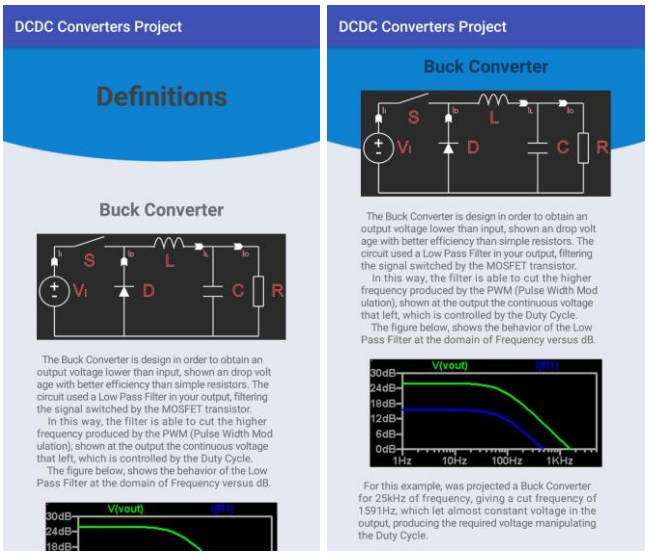
From de results pages, one can then proceed to the advanced calculations, Figure 8, selecting the “Advanced” button independently of the mode select. The results include the following parameters: Critical Inductance, Input Current, Output Current, Switch Current, Diode Current, Inductor Current Variation (A), Capacitor Voltage Variation (V). The conduction mode obtained from the project is also presented in this page. It is important to highlight that this app was developed to design converters at the continuous conduction mode. Thus, the advanced calculations results can only be applied to such conduction mode and should be disregarded for any other. If the configuration is such that the obtained conduction mode is discontinuous, the project needs to be restarted and the inductor value must be greater than the critical value calculated, resulting in continuous conduction mode. The figure also shows the buttons for access the pages of Snubber and E-Core inductor project.

3.4.1 Snubber Project

Based on these values, it is possible to calculate the Snubber, which must be fill with two input values, Time Delay Off (ns) and Time Delay Fall (ns). These values are found in

the datasheet of the switch that will be used in the converter design. For this example, it was used the MOSFET IRF740. The activity is show in Figure 9.

Figure 6 – Concepts definitions



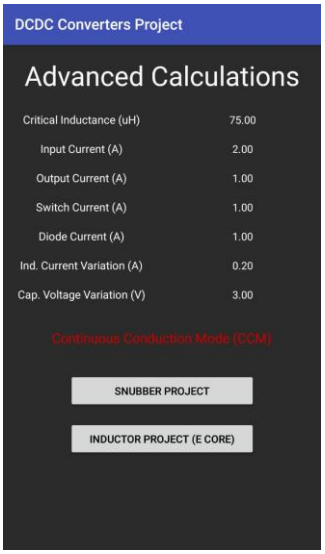
Source: Author, 2018.

Figure 7 – Symbols activity



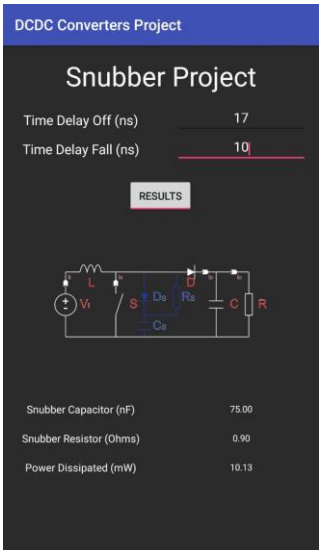
Source: Author, 2018.

Figure 8 – Advanced Calculations



Source: Author, 2018.

Figure 9 – Snubber Project



Source: Author, 2018.

3.4.2 E-Core Inductor Project

Selecting the "Inductor Project (E CORE)" in the Advanced Calculations activity, the next page is shown by Figure 10, where is possible to obtain the full project of an E-Core inductor for the required converter. In this page, the following values are requested for the input data: Use of winding area (%), Jmax (A/mm²) (Maximum Current Density) and Bmax (T) (Maximum Flux Density). This section still in development, but a demonstration is shown by Figure 10. The partial results are Size Percent (%), Air Gap (mm), Core Model, Number of Turns, American Wire Gauge (AWG) and Numbers of Parallel Conductors.

Figure 10 – Inductor Project



Source: Author, 2018.

4 FINAL CONSIDERATIONS

From the presented data, it is possible to observe the facility and practicality that the application has the potential to bring to anyone who needs to design a DC-DC converter, from the most basic parameters to the complete Snubber design and the E-Core inductor. One of the main objectives of this software, besides establishing a practical means for the design of converters, is to make accessible the understanding of this area of power electronics, even if the user does not understand the subject, can still learn and train the design of a DC-DC converter within the application itself. Taking into consideration the initial stage of development, there is still much to improve, seeking to implement more functions and making it more complete with each update.

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