



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**FACULTY OF ELECTRICAL ENGINEERING**

**REPORT FINAL YEAR PROJECT 2**

**DESIGN OF DC BOOST CONVERTER IN CONTINUOUS CURRENT  
MODE**

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MODE**

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**A report submitted in partial fulfilment of the requirement for the Degree of  
Electrical Engineering**

**Faculty of Electrical Engineering**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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## APPROVAL

I hereby declare that I have read through this report entitled “Design of DC Boost Converter in Continuous Current Mode” and found that it complies the fulfilment for awarding the degree of Bachelor of Electrical Engineering.

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## DECLARATION

I declare that this report entitled “Design of DC Boost Converter in Continuous Current Mode” is the result of my own research expect as cited in the reference. This report has not been accepted for any degree and is not concurrently in candidature of any other degree.

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Date : \_\_\_\_\_

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## ABSTRACT

DC-DC converters are widely used in regulated switch mode DC power supplies. The input of these converters is an unregulated DC voltage and therefore it will fluctuate due to the disturbances in the system. This project presents a design and analysis of DC-DC boost converter for continuous current mode (CCM). This system has a non-linear dynamic behaviour, as it work in switch-mode. Moreover, it is exposed to significant variations which may take this system away from nominal conditions, due to changes on the load or the line voltage at the input. DC-DC boost converter is developed and simulated using MATLAB Simulink software. MATLAB Simulink tool environment is used for plotting the waveforms and implementing mathematical equations. In this project, the equations of a boost converter are analyzed and a design of components and simulation of DC-DC boost converter are proposed. Other than that, the changes of duty cycle ( $D$ ) for boost converter affect the whole operation of the system and analyze an output waveform of simulation part and hardware part.

## ABSTRAK

Penukar DC-DC digunakan secara meluas dalam mod suis terkawal bekalan kuasa DC. Masukan dari penukar ini adalah voltan DC yang tidak dikawal dan oleh itu ia akan berubah-ubah disebabkan oleh gangguan dalam sistem. Projek ini membentangkan reka bentuk dan analisis simulasi DC-DC boost converter untuk mod semasa berterusan (CCM). Sistem ini mempunyai kelakuan dinamik yang tidak setara, kerana ia berfungsi dalam mod suis. Selain itu, ia terdedah kepada variasi ketara yang mungkin mengambil sistem ini dari keadaan nominal, disebabkan oleh perubahan beban atau voltan garisan pada input. DC-DC boost converter dibangunkan dan disimulasikan menggunakan perisian MATLAB Simulink. Persekitaran alat MATLAB Simulink digunakan untuk merancang bentuk gelombang dan melaksanakan persamaan matematik. Dalam projek ini, persamaan rangsangan penukar dianalisis dan reka bentuk komponen dan simulasi penaik rangsangan DC-DC dicadangkan. Selain daripada itu, perubahan kitaran duti ( $D$ ) bagi penukar rangsang menjejaskan keseluruhan operasi sistem dan menganalisis bentuk gelombang keluaran.

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## CHAPTER 1

### INTRODUCTION

This chapter will describe the project background, problem statement, project objective, and project scope. In this project background, it will briefly the description of the “Design of DC Boost Converter in Continuous Current Mode” and study the waveform in continuous current mode (CCM) as well as the project objective and scope.

#### **1.1: Project background**

DC – DC converter are power electronic circuit that convert a dc voltage to a different dc voltage level. It important component in many applications and power capability demands. It may applicable in electric vehicle, uninterruptable power supply (UPS), photovoltaic (PV) system, and fuel cell system. The DC – DC converter can be divided into two categories which are non-isolated and isolated converter. This report is focus on the boost converter is one type of non-isolated converter. It can raise low input voltage and current to higher output voltage and current. The circuit diagram of boost converter is shown as in Figure 1.1.

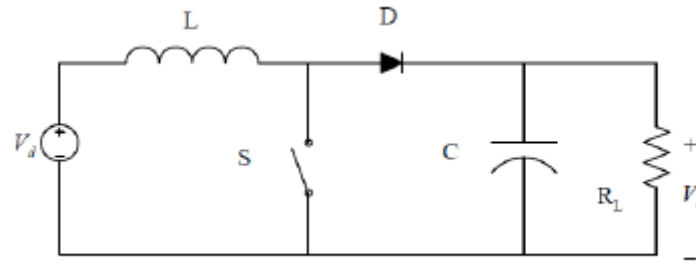


Figure 1.1: Circuit boost converter

The principle thought of this report is to design a boost converter and analyse a waveform in continuous current mode. The simulation of the circuit will be finished by utilizing in MATLAB software. Also the hardware prototype will be do and to compare and analysis the result from simulation and hardware.

## 1.2: Motivation

A boost converter is used in renewable energy system to step up an unregulated DC voltage to a higher constant output voltage that required by load and batteries. The design and development of boost converter is mainly concern of its output voltage, current ripple and ease of design. Renewable energy such as solar system and wind uses boost converter as a medium of power transmission to perform energy absorption to load and batteries. For conventional DC –DC boost converter has a higher current ripple. In this project the current ripple is main important to reduce with selecting the best value of parameter.

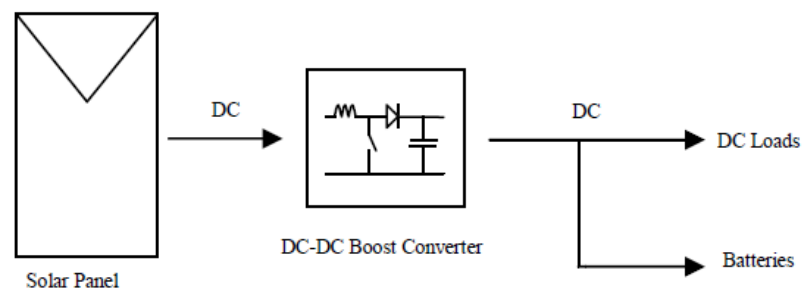


Figure 1.2: Block diagram of solar system



### **1.3: Problem statement**

Nowadays, the DC-DC boost converter is the common step up power converter used in many applications because it can convert from low input voltage to high output voltage by controlling the duty cycle of the power switch. But for the conventional boost DC-DC converter, it produce large output current ripple and input current ripple. For an ideal circuit, the ripple must be avoided so that any application can perform at its optimum performance. The ripple can reduce efficiency and thus reduce the performance itself. Therefore to overcome this problem, the selected value of capacitor and inductor is very important to make sure the ripple will reduce. This research is analyzing the waveform boost converter in continuous current mode. The main challenge faced by this study is to design a boost converter from a data in calculation and simulation.

### **1.4: Objective**

The objectives of this project are:-

1. To design and obtain a boost converter circuit with the correct value of parameter.
2. To perform simulation of boost converter by using a MATLAB software.
3. To develop hardware prototype of the DC – DC boost converter.
4. To analyze an output waveform of simulation and hardware part.

### **1.5: Scope project**

This project primarily focuses on designing the DC – DC converter circuit, examining the circuit, analyzing the output and comparing the result of boost converter in continuous current mode. The circuit are design and simulate by using MATLAB / SIMULINK software. The pulse width for the switching controller is generated by using programming developed by Infineon XMC4500. The hardware implementation of the DC-DC switching boost converter is based on the simulation done in MATLAB software. This project will cover the fundamental knowledge of DC – DC converter topic only.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1: Introduction

This chapter review the existing project created to get an idea about the boost converter by following conception, specification and any information that related to the project. In later of this chapter, some review about the proposed design of boost converter to fulfil this project will be reported.

#### 2.2: Converter

Converter is defined as a electronic circuit that convert one type or level of voltage to another level voltage waveform. It serves as the connector between power source and load. [1]

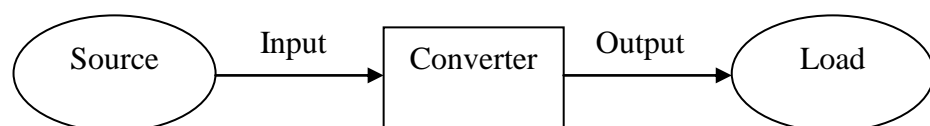


Figure 2.1: Basic converter operation

Converters are classified into four types by the relationship between input and output:

Table 2.1: Classification of converter

<b>Type of converter</b>	<b>Functions</b>
AC input/DC output	The AC/DC converter that produces a DC output from an AC input. It classified as a rectifier.
DC input/AC output	The DC/AC converter that produces a DC output from a DC input. It classified as a inverter.
DC input/DC output	The DC/DC converter that produces a DC output from a DC input. It classified as a regulator.
AC input/AC output	The AC/DC converter that produces a DC output from an AC input. It used to change the level and/or frequency of an AC signal.

### 2.3: DC - DC Converter

A dc - dc converter can be defined as a power electronic circuit that convert a dc voltage to a different dc voltage level. It often provided a regulated output [2]. DC - DC converter is required because it operation not similar like AC which the DC cannot be step-up or step-down using a transformer. DC converter is an equivalent to a transformer [3].

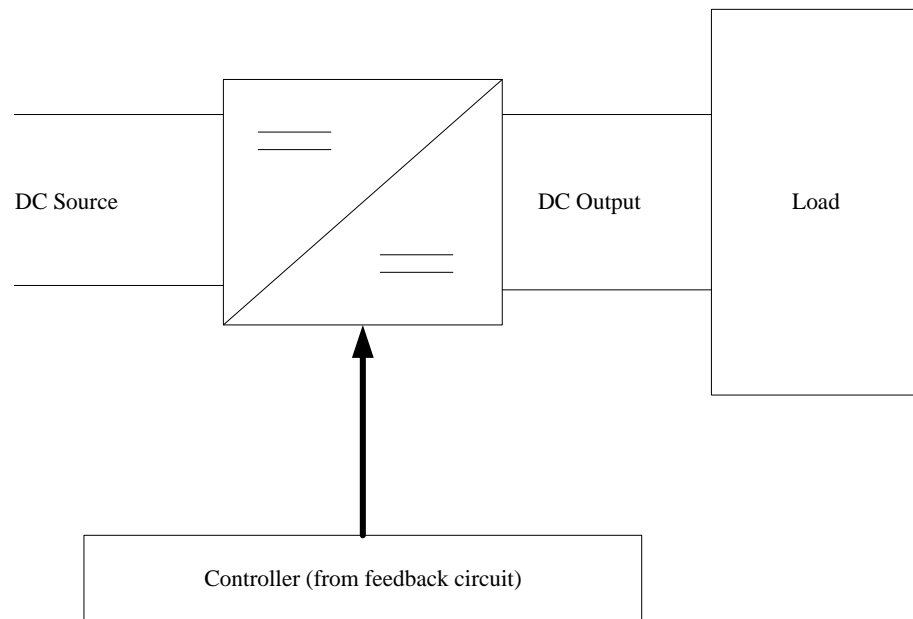


Figure 2.2: General DC – DC converter block diagram

DC-DC converters include buck converters, boost converters, buck-boost converters, Ćuk converters and full-bridge converters. Switched DC-DC converters offer a method to increase or decrease an output voltage depend on application or system. DC-DC converters operated in two modes according to the inductor current. The inductor current fluctuates but never goes down to zero is called Continuous Conduction Mode (CCM) and Discontinuous Conduction Mode (DCM) happen when the inductor current fluctuates and goes down to zero at or before the end of each cycle.

Energy is periodically stored into and released from a magnetic field in an inductor. This is applied to control the output voltage so that the output remains constant even though the input voltages keep changing. There are two categories of DC-DC converters that are non-isolated DC-DC converter (Buck, Boost and Buck-Boost) and isolated DC-DC converter (Flyback, Forward, Push-Pull, Full-Bridge and Half-Bridge).

Non-isolated DC-DC converter is used when the input of converter is often an unregulated Dc voltage, which is obtained by rectifying the line voltage. Therefore, it will vary due to the changes in the line voltage magnitude. Switched-mode DC-DC converters are used to convert the unregulated DC input to a controlled DC output at a desired voltage level.

Isolated DC-DC converter, full-bridge converter and half-bridge converter are derived from the step-down converter. Flyback converter is derived from the buck-boost converter. Forward converter and push-pull converter are derived from the step-down converter with isolation.

### 2.3.1: DC – DC converter switching

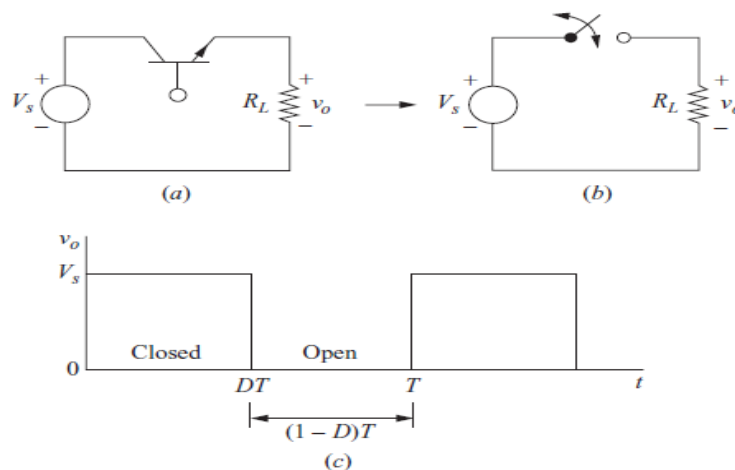


Figure 2.3: (a) Basic dc-dc switching converter; (b) Switching equivalent; (c) Output voltage

Figure 2.3 shown a basic switching converter and the switch is ideal. The output voltage is comparable to the input voltage when the switch is on and the output voltage is zero when the switch is off. This condition will produced waveform as in Figure 2.2(c). The DC component of the output voltage is regulated by varying the duty ratio  $D$ , which is the division of the switching period when the switch is off. The DC component of the output voltage will be lower than or same to the input voltage for the circuit.[1]

## 2.4: Study of DC – DC Converter

### 2.4.1: Boost Converter

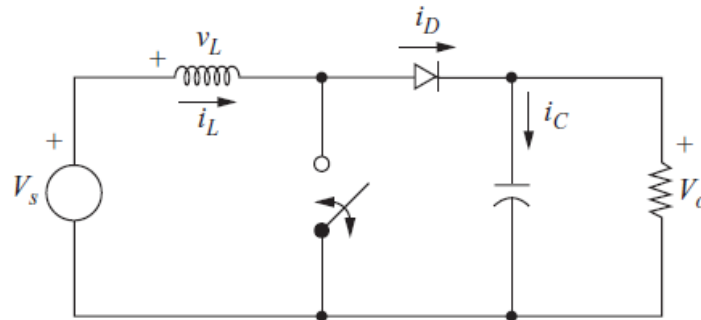


Figure 2.4: Boost converter circuit

The boost converter is shown in figure above and as well known as the output voltage is larger than the input voltage.

To analyze boost converter, following characteristics is being assumed:

1. Steady-state conditions exist.
2.  $T$  is the switching period and the switch is closed at time  $DT$  and open at time  $(1-D)T$ .
3. The inductor current always positive and it is continuous.
4. The capacitor value is very large and the output voltage is held constant at voltage  $V_o$ .
5. The components are ideal.

The inductor current and voltage are analyzed during switch is closed and switch is opened. When the switch is closed (OFF), the diode operates in reverse-biased.

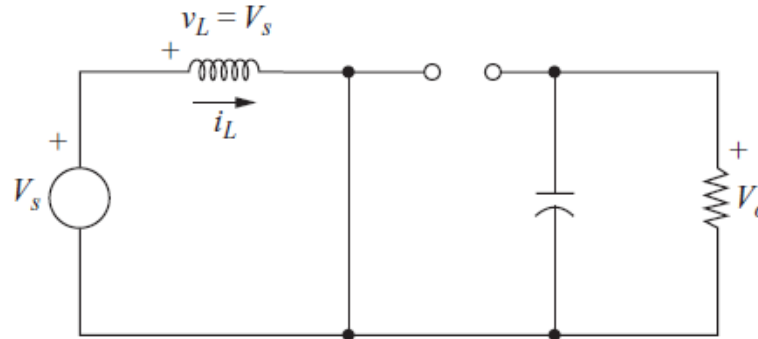


Figure 2.5: Boost converter circuit for switch closed (OFF)

Therefore, the Kirchhoff voltage law for the circuit in figure 2.11,

$$v_L = V_S = L \frac{di_L}{dt} \quad (2.1)$$

Rearranging,

$$\frac{di_L}{dt} = \frac{V_S}{L}$$

$$\frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{DT} = \frac{V_S}{L}$$

$$(\Delta i_L)_{closed} = \frac{V_S DT}{L} \quad (2.2)$$