

# Analysis and Modelling of DC-DC Power Boost Converter

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**Abstract** — In present scenario the demand of portable devices increasing day by day like mobile, laptop, small electrical devices and office equipment etc., and to full fill this demand we use different types of dc-dc converters. DC-DC converters are used for complicated applications. In this paper present analysis and modelling of dc-dc boost converter. A boost converter step up voltage from its input supply to its output load. It is also called as step up converter. By using this converter we can give particular output voltage to the particular small devices. In this paper we have designed and implemented a boost converter with LM2577 IC and main converter circuit with the components like switch, diode, inductor, capacitor and a load. The comparison of both circuit, simulation results as well as hardware results represents the performance of the proposed design.

**Keywords** - DC to DC buck converter, Integrated circuit (IC's), Inductor, Capacitor.

## 1] INTRODUCTION

In recent years dc to dc converters are mostly used in switched mode power supplies. DC to DC power converters are employed in a variety of applications, including power supplies for personal computers, office equipment, spacecraft power system, laptop, computers and telecommunication equipment as well as dc motor drives. The dc to dc converter is a dc power supply that is small, light in weight and highly efficient and uses a semiconductor switching element, it can response quickly. There are four basic dc to dc converter topologies: Buck, Boost, Buck-Boost and buck. Out of these converters only two basic converters are mostly used i.e. buck and boost. We can derive other converters by using these two converters.

A boost converter is a converter that takes the input voltage and increases that voltage at the output the basic circuit of boost converter is as shown in fig.1.

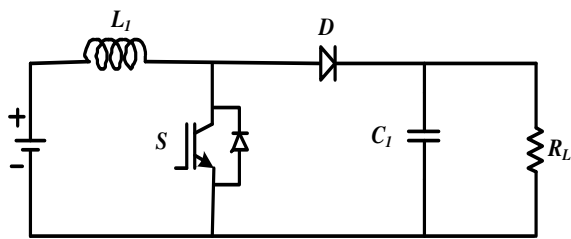


Fig.1 basic circuit of boost converter.

In switch mode power supply we always have an active switch and usually have a passive switch. There are four components in boost converter. Which are inductor, electronic switch, diode, and output capacitor. In boost converter inductor is connected in series with a voltage source. The inductor current and source current are equal.

## CONTINUOUS CONDUCTION MODE

Under this mode, it is divided into two modes Mode1 When switch is closed as shown in fig 2. The input current which increases flows through inductor L and switch S. During this mode, energy stored in the inductor. Mode2 when the switch is open as shown in fig 2. The input current is flowing through inductor L, capacitor C, diode D, and load R. Energy stored in the inductor is deliver to the load. Therefore the output voltage is greater than the input voltage.

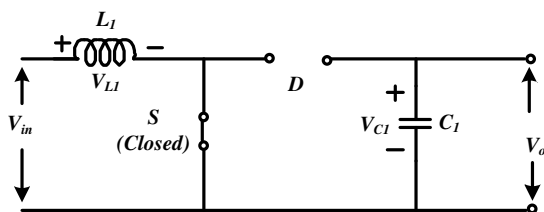


Fig2. Mode1- circuit diagram of boost converter during  $T_{ON}$ .

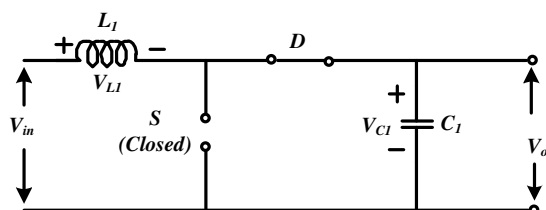


Fig3. Mode2- circuit diagram of boost converter during  $T_{OFF}$ .

$$V_{L(ON)} T_{ON} + V_{L(OFF)} T_{OFF} = 0$$

$$V_s DT + (V_s - V_o) (1-D) T = 0$$

$$V_o (1-D) = V_s$$

$$V_o = \frac{V_s}{(1-D)} \quad (1)$$

Where  $V_o$  is the output voltage,  $D$  is duty cycle, and  $V_s$  is the input voltage. The range of the duty cycle is lie between  $0 \leq D < 1$ . It will never reach to 1

The converter operates in continuous conduction mode, inductor current  $I_L$  flows continuously and it never goes to zero as shown in fig4. To find inductance always put  $I_{Lmin} = 0$ .  $L$  is given by

$$L_{min} = \frac{D(1-D)^2 R}{2f}$$

Where  $L_{min}$  is the minimum inductance,  $R$  is output resistance, and  $f$  is the switching frequency of the switch.

The output capacitance is given by

$$C_{min} = \frac{D}{2fR} \quad (3)$$

Where  $C_{min}$  is the minimum capacitance

## DISCONTINUOUS CONDUCTION MODE

In this mode, the inductor current  $I_L$  does not flow continuously. The inductor current starts from zero during ON condition and increases linearly when the switch will be close means during ON time but in discontinuous conduction mode inductor current does not go at  $T$ . the inductor current is zero at  $T \geq$  time period.

## 2] BOOST CONVERTER WITH LM2577

The LM2577 is a useful IC it provides all of the power and control functions for a step up, fly back, and forward converter switching regulator. The IC has a broad input voltage range (3.5V to 40V) and it is accessible in different output voltage (12V, 15V, and adjustable.) It requires minimum number of external components, the cost of these regulators are very effective and easy

to use. The application of LM2577 as shown in fig3. In this application the input voltage is 5v and it converts 5v to fixed 12v output. It has some distance advantages like resulting in poor efficiency, wasted power and continuous heat generation. The main disadvantage is that, their maximum continuous output current rating is limited to just a few amperes or so. And some applications are simple boost regulator, flyback and forward regulators, multiple-output regulator.

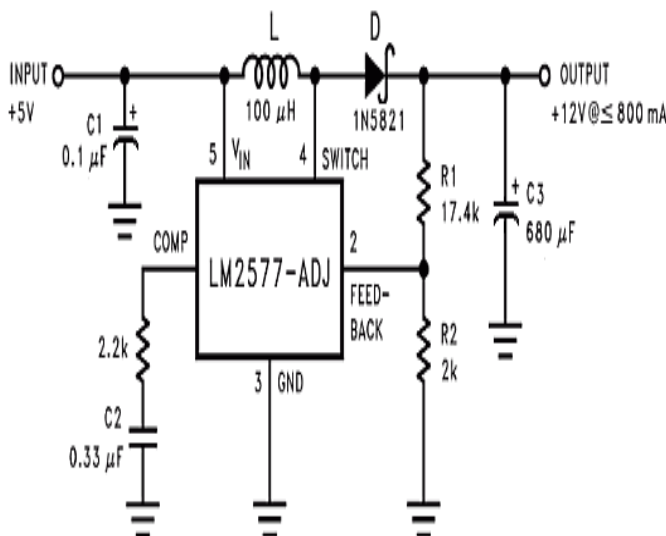


Fig3. Boost converter with LM2577.

### 3] DESIGNING OF BOOST CONVERTER CIRCUIT USING SWITCHING REGULATOR

When higher output voltage or current power supplies are required switching regulators are used. Switching regulator commonly known as switch mode power supply. A boost switching regulator is a type of switch mode power supply that is designed to increase DC voltage from a lower voltage to a higher voltage. For example a boost converter can convert 3 volts to 5 volts. The basic circuit of boost converter using arduino and N-channel MOSFET as shown in fig4. The major advantage of the switch mode power supply is its higher efficiency, and this is achieved by power MOSFET. Boost converters are mostly used in capacitive circuit applications such as battery chargers, photoflashes, strobe flashes, etc.,

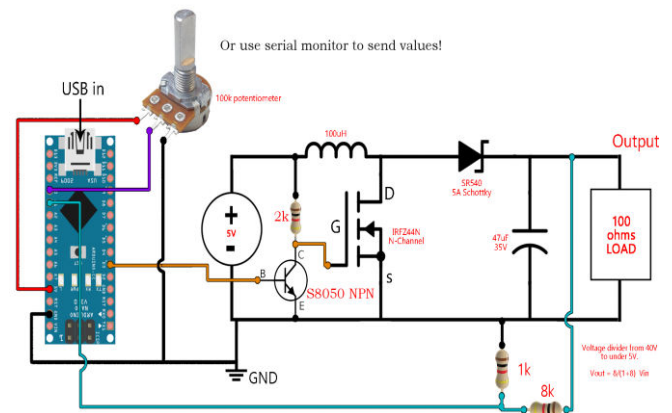


Fig4. Control of boost converter using regulator.

## ARDUINO

The Arduino UNO is a low cost microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller, power to it with an AC to DC adapter or battery to get started. The MATLAB also supports the arduino and communicate through the computer serial port. The arduino has a 5v linear voltage regulator that will lower efficiency of the circuit. The main function of the arduino is to learn how the circuit, the feedback and the PWM signal work in order to achieve the desired output. The buck converter parameters are connected as shown in fig. we have a potentiometer connected to the analog input A0. With this potentiometer we will choose the output value.

## COMPARISON OF LINEAR REGULATOR (LM2577) AND SWITCHING REGULATOR (MOSFET)

### 1. LINEAR REGULATOR

Linear regulators are used for low powered devices. Even they are easy to use, simple and cheap, it is normally insufficient because the difference between the input voltage and regulated output voltage is continually dissipated as heat.

## 2. SWITCHING REGULATOR

Switching regulators are highly efficient and wide input and output range internal compensation. Complexity is medium to high. Waste heat is low.

### DESIGN

#### Specifications with LM2577

Input voltage = 5V

Output voltage = 12V

Switching frequency = 52 kHz fixed frequency

L1: 100  $\mu$ H

D1: 1N5821

C1: 0.1  $\mu$ F

C2: 0.33  $\mu$ F

C3: 680  $\mu$ F

R1: 17.4K

R2: 2K

#### Specification with switching regulator

Input voltage: 3V

Output voltage: 5V

N-channel MOSFET: IRF44N

Inductor: 100  $\mu$ H

Capacitor: 47  $\mu$ F

Resistor: 10k $\Omega$ , 100 $\Omega$

Schottky diode: SR540

Arduino UNO

Potentiometer: 100k $\Omega$

R1: 1K

R2: 8K

## SIMULATION RESULT

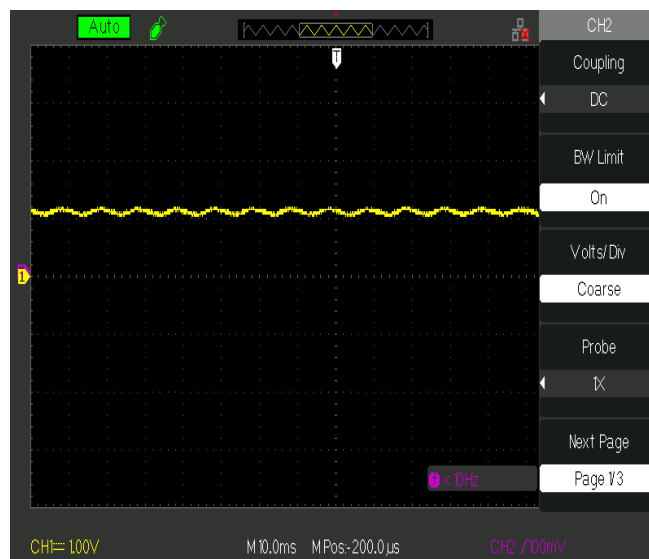


Fig5 (a). Input of boost converter with LM2577

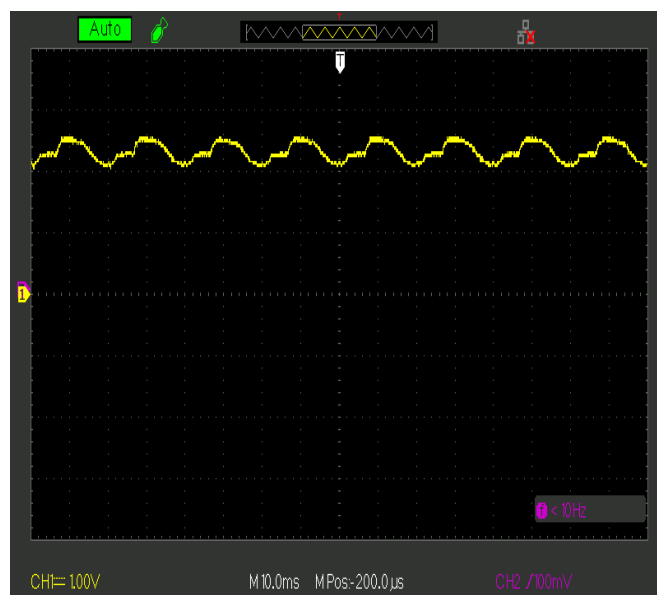


Fig5 (b). Output of boost converter with LM2577





Fig5 (c). Input of boost converter using switching regulator.



Fig5 (d). Output of boost converter using switching regulator.

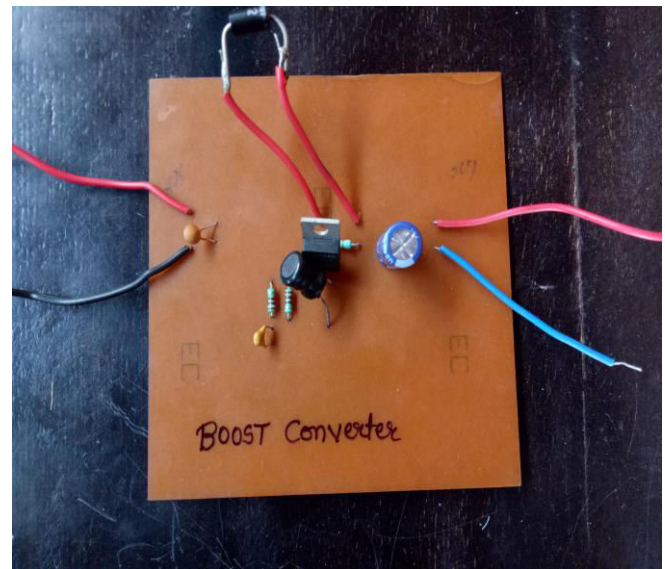


Fig5 (e). Hardware of boost converter with LM2576.

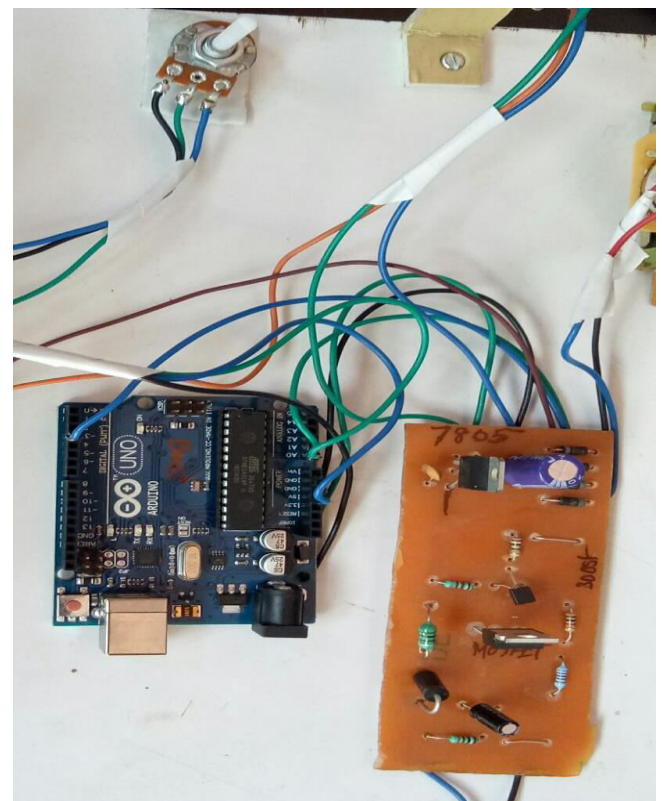


Fig5 (f). Hardware setup of boost converter with arduino

## HARDWARE IMPLEMENTATION

## CONLUCTION

In this paper, boost converter is designed and simulated in both with LM2577 and without and hard ware also implemented for both with LM2577 and without by using Arduino microcontroller for low power applications, and most of the electronics systems. Since arduino is used for better flexibility in control system for any change in supply voltage and load. And as compare to linear regulator switching regulator is better.

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