Adaptive Approach for Reducing the Total Harmonic Distortion of Boost Converter using PWM Switching

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Abstract: *This paper proposes the MATLAB- simulation of adaptive approach for reducing the total harmonics distortion of boost converter using PWM switching. The main aim of boost converter is to maintain the constant output voltage despite variation in input voltage, components and load. The closed loop implementation of converter can maintain the constant output voltage. This papers aim to achieve a better efficiency low harmonic distortion and also to achieve a better stability, improves the dynamic response and reduces the steady-state error with the Least mean square algorithm.*

***Key Words*: Boost converter, THD, PID, Least Mean Square (LMS)**

1. INTRODUCTION:

In various applications switched mode converters are widely required by several components of an electronic product that are designed to be operated under a constant voltage. DC-DC converters are applied in battery, bioelectric products, photovoltaic cell, power systems telecommunication, high voltage dc transmission, and many other applications[1][2]. As all Batteries can't efficiently full fill the requirement of the today's electronic products so DC-DC converter are required. Boost power converters have been widely used for Power Factor calculation and correction in AC-DC conversions [3] and for power management in battery powered DC-DC conversions. Moving beyond low-power applications, such as cellular phones, smart phones and other portable electronic products, boost converters are being used more and more in medium-power applications. For example, in computing and consumer electronics telecommunication, transportation, utility systems, etc. [4], [5]. In communications and industrial products, simple boost converters are used in satellite dish auxiliary power supplies and peripheral card supplies [6].

Several control techniques have been proposed to ensure stability as well as fast transient response namely - Fuzz Logic controller, Artificial Neural Network (ANN), PID controller and PI controller. Several Optimization techniques such as Genetic Algorithm, Particle Swarm Optimization, and Bacterial Foraging Optimization have also been proposed[7],[8],[9].

There are some famous DC-DC converters namely –

Buck, Boost, Buck-Boost, Cuk, Sepic and Zeta. One of the most prominent research interests in this era is the application of DC-DC converters with high step-up voltage gain[10]. Amongst all converters, most widely used DC-DC converter is the Boost converter, a step up converter which Provides a higher voltage at the load side, *Vo* compared to the source voltage *Vs*. Open loop mode of operation of Boost Converter exhibits substandard voltage regulation and Undesirable dynamic response. Therefore, closed loop mode of operation is preferred for proper voltage regulation and Performance enhancement.

In power electronics due to continuous switching of operation of switches there is losses occurs .This losses will reduced the efficiency of the system and increased the total harmonics distortion of the system. This paper initially involves simulation of basic simulation of boost converter and calculation of THD.Its start with the basic circuits and switches to advance circuits such us LMS algorithm and effects of LMS on boost converter performance and results of THD.

1.1 Harmonics:

The harmonics in electrical systems means that current and voltage are distorted and differ from sinusoidal waveforms.

1.2 Total Harmonics Distortion:

Total harmonic distortion, or THD, is the summation of all harmonic components of the voltage or current waveform compared against the fundamental component of the voltage or current wave:

$$THDf = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2}}{V_1} \quad \text{........................(1)}$$

2. Block Diagram

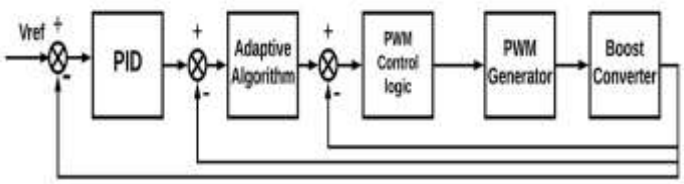

Fig 1.Block Diagram

2.1 Boost Converter:

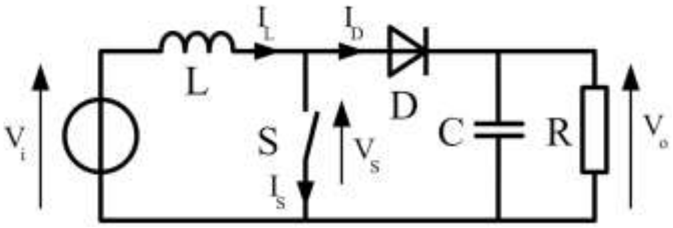

Fig 2.Boost Converter

The basic principle of a Boost converter consists of 2 states :

- In the On-state, the switch S is closed, the current start flowing through the inductor. Hence inductor starts storing the enrgy.
- In the Off-state, the switch is open and inductor discharge through freewheeling diode, capacitor and Load R.

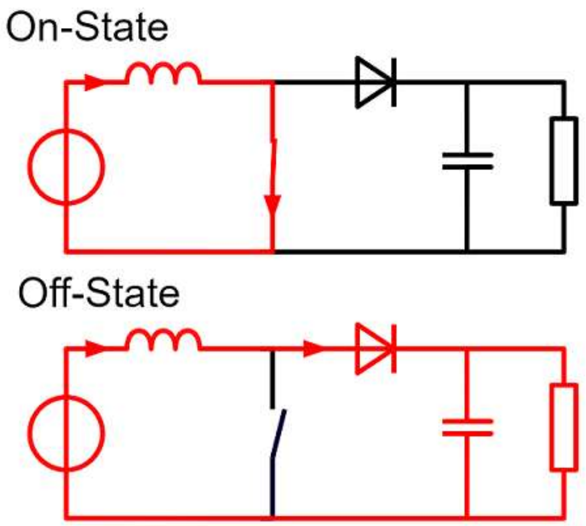

Fig 3.On-state and Off-State of Boost converter

The Transfer Function of Boost Converter is..

$$\frac{V_o}{i_L}(s) = \frac{R(1-D)\left\{1 - \frac{sL}{R(1-D)^2}\right\}(1+sRC)}{2+sRC} \quad \text{.........(2)}$$

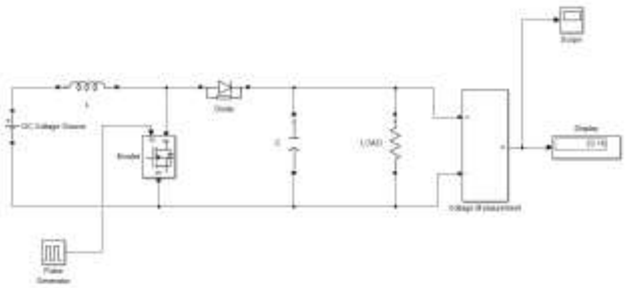

Fig 4:Boost Converter

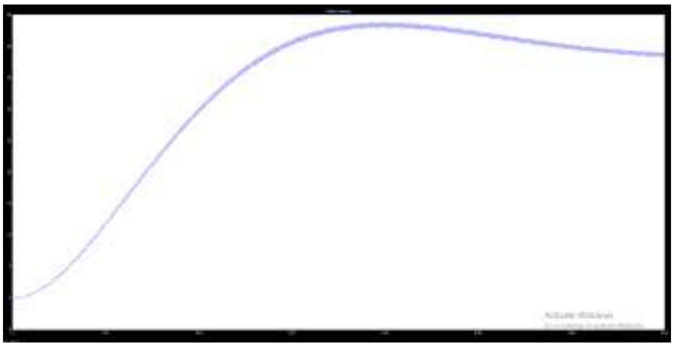

Fig 5: Output voltage wave form of Boost converter

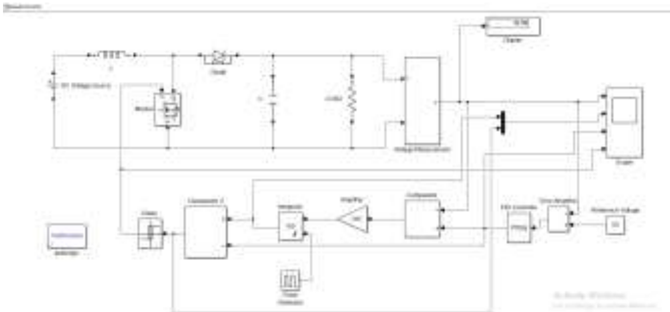

Fig 6: Simulation Boost converter with PID Controller

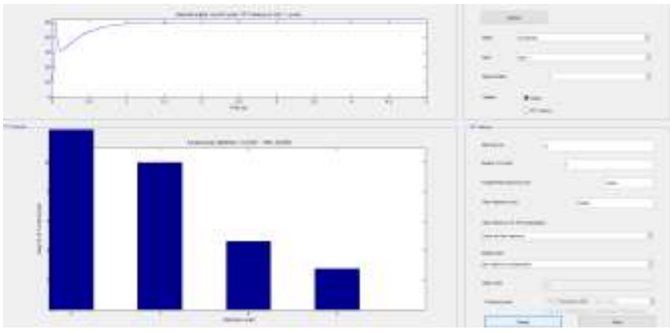

Fig 7: Boost Converter with PID Controller and THD

The tracking error obtained from the difference between the reference signal which serves as the input *R(t)* and the actual output signal *Vo(t).* The tracking error is fed on to the PID controller which computes the derivative and integral of the signal provided. The output of the PID controller *u(t)* to be applied to the plant is equal to the proportional gain (KP) times the magnitude of the error signal plus the integral gain (KI) times the integral of the error signal plus the derivative gain (KD) times the derivative of the error signal.

Time domain representation of the signal u(t) fed to the plant is given by –

$$u(t) = K_p e(t) + K_i \int e(t)dt + K_d \frac{de(t)}{dt} \quad \text{.........1..........(3)}$$

The plant on receiving the signal *u(t)* will generate a modified output *Vo(t)* which will be again compared to the reference signal until the desired level is reached thereby forming a close loop system.

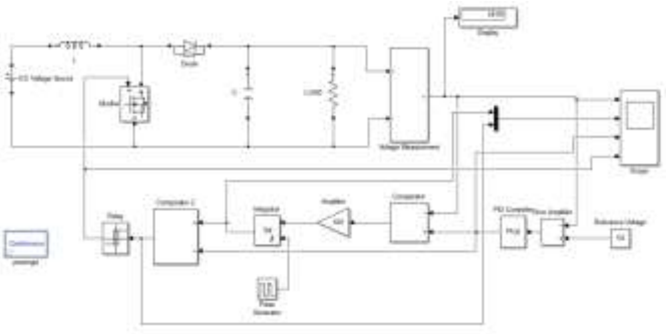

Fig 8:Boost Converter with LMS algorithm

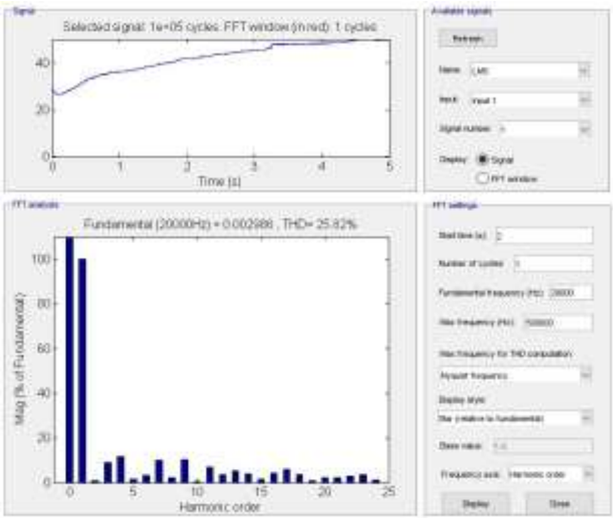

Fig 9:Boost converter with PID+LMS and THD

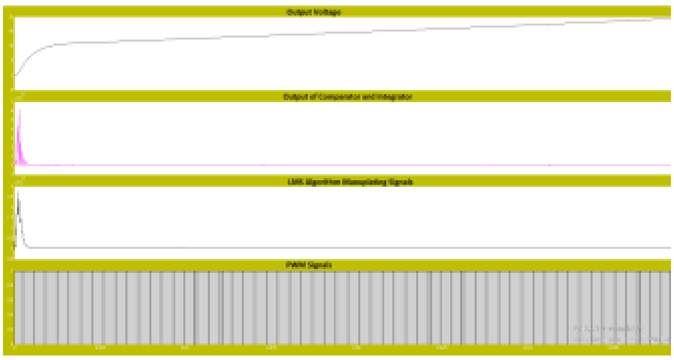

Fig 7: Output of Boost Converter with LMS algorithm

Boost converter parameters are as given in Table I

Parameters	Value
Input voltage	12V
Output voltage	49.99V
Inductor value	100µH
Capacitor value	1000µF

Table I: Boost Converter Parameters

3. CONCLUSION

The proposed boost converter gives the better voltage regulation and reduced the steady state error of the system than the conventional Boost converter. It also reduces the total harmonics distortion of the systems. The comparison is shown in table no.II

Circuit Topologies	THD	Output Voltage
Conventional Boost Converter	64.54%	23.18V
Boost converter with PID	49.56%	49.98V
Boost Converter With PID and LMS	25.28%	49.85V

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