

# Applying Mathematical analysis of Fast Fourier Transform to Voltage controlled Inverter circuit

<sup>1</sup>G. Veeresh

<sup>1</sup>Assistant Professor, Department of Humanities & Sciences,  
Dr. K. V. Subba Reddy College of Engineering for Women, Kurnool, Andhra Pradesh  
*Iveereshpoly123@gmail.com*

<sup>2</sup>U.Sujatha

<sup>2</sup>Assistant Professor, Department of Humanities & Sciences,  
Dr. K. V. Subba Reddy College of Engineering for Women, Kurnool, Andhra Pradesh

## Article Info

Volume 83

Page Number: 2048 - 2050

Publication Issue:

March - April 2020

## Abstract

In the context of applying mathematical analysis, an electrical related inverter circuit has been selected and analyzed its circuit parameters. The tool of fast Fourier transform has been applied to the circuit and simulated in MATLAB software. The electrical parameters like voltage and current have been obtained and thereby the differential equations are derived from the basic methods of Kirchhoff's current and voltage laws respectively. The role of mathematics has been discussed in this paper for understanding the circuit behavior and further investigating the circuit values.

## Article History

Article Received: 24 July 2019

Revised: 12 September 2019

Accepted: 15 February 2020

Publication: 18 March 2020

**Keywords:** Fast Fourier transforms analysis, Kirchhoff's current and voltage law, MATLAB.

## I. INTRODUCTION

Mathematical analysis is an essential tool in investigating the circuit nature as well as input and output values of any circuit [1]. Many researchers have already investigated the non linear behavior of the electrical related circuits and represented their way of illustrations in a lucid manner [2, 3]. In this paper, emphasis is given on observing the voltage and current based non linear kind of behavior by applying the Fourier transform technique through MATLAB. The mathematical derivation is done on the selected circuit and obtained the equations which are illustrated in section II of this paper.

technique to find the harmonic distortion which should be reduced to the maximum extent for smooth functioning of the electrical system.

## II. MATHEMATICAL ANALYSIS

This paper basically throws light on finding the harmonic content which is obtained through fast Fourier transform in MATLAB/SIMULINK. The dynamics of the circuit is represented mathematically as follows:

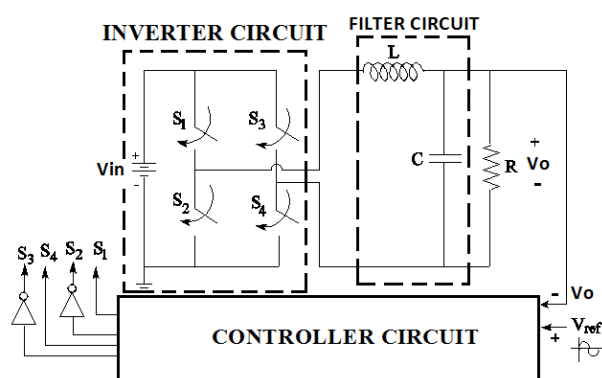


Fig: 1 Schematic layout voltage controlled inverter

When two switches S1 and S4 are turned 'ON',

Mathematically, we obtain the first order differential equation through KVL, as follows:

$$\frac{di_L}{dt} - \frac{V_{in}}{L} = \frac{V_0}{L} \text{ ----- (1)}$$

$$\frac{dV_0}{dt} - \frac{i_L}{C} = \frac{V_0}{RC} \text{ ----- (2)}$$

From (1) we get,

$$\frac{di_L}{dt} = \frac{V_{in}}{L} - \frac{V_0}{L} \text{ ----- (3)}$$

Equation (3) explains about the time varying current state variable which is flowing in the inductor circuit.

From (2) we get further equation,

$$\frac{dV_0}{dt} = \frac{i_L}{C} - \frac{V_0}{RC} \text{ ----- (4)}$$

Equation (4) explains about the time varying voltage state variable which is available across the capacitor in filter circuit.

When the other two switches namely: S2 and S3 are turned 'ON', the mathematically, we get the following differential equations, namely:

$$\frac{di_L}{dt} + \frac{V_{in}}{L} = \frac{-V_0}{L} \text{ ----- (5)}$$

$$\frac{dV_0}{dt} = \frac{i_L}{C} - \frac{V_0}{RC} \text{ ----- (6)}$$

If the above equations are combined to form a matrix form, we obtain,

$$\begin{bmatrix} \frac{di_L}{dt} \\ \frac{dV_0}{dt} \end{bmatrix} = \begin{bmatrix} 0 & \frac{-1}{L} \\ \frac{1}{C} & \frac{-1}{RC} \end{bmatrix} \begin{bmatrix} i_L \\ V_0 \end{bmatrix} + \begin{bmatrix} \frac{V_{in}}{L} \\ 0 \end{bmatrix} (2k-1) \text{ -----}$$

- (7)

Where  $k \in [0,1]$

### III. SIMULATION RESULTS

The simulation results represent the harmonic spectrum analysis of the inverter circuit with voltage as input parameter. The fast Fourier transform technique has been applied in MATLAB and obtained the following spectrum output.

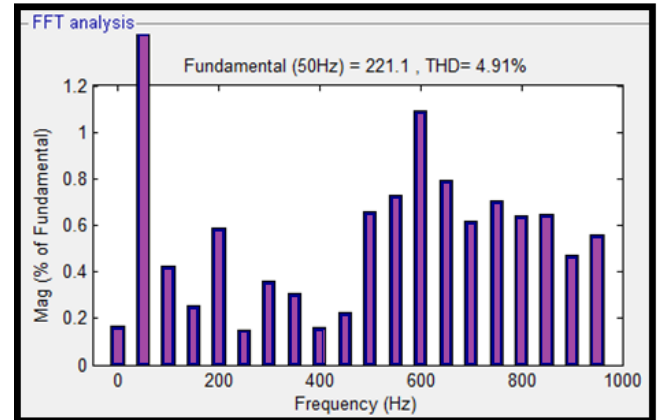


Fig: 2 Harmonic analysis of inverter through Fast Fourier transform for low R.

The harmonic spectrum plot shown in Fig. 2 has been obtained for low resistance value 6 ohms in MATLAB.

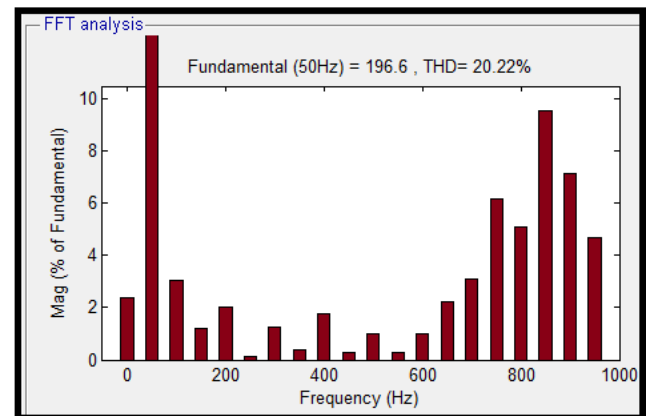


Fig: 3 Harmonic analysis of inverter through Fast Fourier transform for high R.

The harmonic spectrum depicted in Fig. 3 has been obtained for high resistance value of 110 ohms in MATLAB

### IV. CONCLUSION

This paper presented the harmonic analysis of the inverter circuit with voltage as the control parameter. The aim of this paper is to show the waveform plots pertaining to the fast

Fourier transform through mathematical illustration. The differential equations explain about the current flowing through the inductor element and the voltage across the capacitor element respectively.

## V. REFERENCES

- [1] Fei-Hu Hsieh, Hen Kung Wang, Po Lun Chang, Sheng Hsiung Lin, "Nonlinear Behaviors in a Voltage-Mode Controlled Half-Bridge Buck Converter via Varying Load Resistance", Proceedings of 2014, International Conference on Machine Learning and Cybernetics, Lanzhou, July, 13 -16, 2014.
- [2] Dong Dai, Ming Li and Xikui Ma, "Slow Scale and Fast Scale Instabilities in Voltage Mode Controlled Full Bridge Inverter", circuits and Systems, Signal Process, Volume: 27, pp: 811 – 831, 2008.
- [3] Fei Hu Hsieh, Hen Kung Wangz, Po Lun Chang Hsuan Chiang, "Nonlinear Dynamic Behaviors in Voltage Mode Controlled Single Phase Half Bridge Inverters via Varying Proportional Gain", Proceedings of the 2011, International Conference on Machine Learning and Cybernetics, Guilin, July 10-13, 2011.