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Design a Pulse Generator with 3rd Harmonic Injection for a Neutral point clam Inverter

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***Abstract* - One of the most popular PWM techniques for controlling the output and harmonic inverter decreased is indeed the sinusoidal pulse width modulation (SPWM) technique. In PWM modulating techniques, recent developments in power electronics and semiconductor technology have lead to the use of upper carrier frequency. The RL load is connected with an LC filter in the presented voltage source inverter. A sinusoidal (SPWM) PWM and the third harmonic injection (THIPWM) PWM are two PWM techniques used to operate converter for voltage source. The results of the simulation reveal that THIPWM outperforms then SPWM A MATLAB Simulink demonstrates and compares both techniques to THD.**

***Index Terms* - SPWM, THD, Voltage source inverter, carrier frequency, third harmonic injection PWM.**

I.INTRODUCTION

The inverter converts DC energy to a.c. stress. For top power applications, three-phase inverters are commonly used. An uninterrupted supply (UPS), an adjustable speed drive, etc., were included in inverter applications.

Voltage source inverter is
These considered parameters are varied to urge desired low harmonics output. during this paper generated by comparing reference wave and triangular wave. Sinusoidal PWM and third harmonic injection PWM techniques are considered to work VSI. they are compared in terms of THD.

II.CONTROL TECHNIQUES

Over the last 20 years, many PWM control strategies were developed [2] to achieve variation of output voltage and PWM control strategies including SPWM, third - harmonic switching frequency, space vector pulse. Most commonly used for 3 phase adapters, width modulations (SVPWM) or 60° PWM are used. SPWM is the simplest of all PWM techniques listed above.]. By comparing reference wave and triangular carrier signal in SPWM technique, the signal specified for the gates of the inverter is generated. THPWM method was developed by Buja in 1975. The difference is that the waveform A.C. reference is just not sinusoidal but consists of both the fundamental and the third harmonic components [1][4]. THPWM is implemented in the same manner as SPWM. The benefits of PWM techniques are that it is easy to use and control, can harmonics of a lower order [5]. In terms of harmonics, SPWM and THPWM development is analysed and compared.

In recent decades, numerous PWM control strategies have already been developed [2]. The third harmonic pulse width (THPWM), space vector pulse width modulation (SVPWM), and six0° PWM, are most often used for a three-phase inverter to achieve variations in the output voltage and modulation of PWM control techniques including such Sinusoidal Pulse Width Modulation (SPWM). The SPWM techniques are the simplest of all. The inverter gates specified signals are:

A. Sinusoidal PWM

Three sinusoidal modulating signals (V_m) at low frequency but displaced from one another by 120° are compared with a high-frequency triangular carrier signal (V_r). The resulting switching signals from each comparator are wont to drive the inverter respective switches. The harmonic content within the converter output waveform is chosen because of the performance criterion and it's desired to minimize for correct operation. The frequency of the reference signal determines the inverter output frequency & the amplitude of the performance criterion and it's desired to minimize for correct operation. The frequency of the reference signal determines the inverter output frequency & the amplitude of the reference signal controls signal controls the modulation index. The harmonic distortion of SPWM is above other switching option, generally at high modulating index. Switching losses also are high in SPWM.

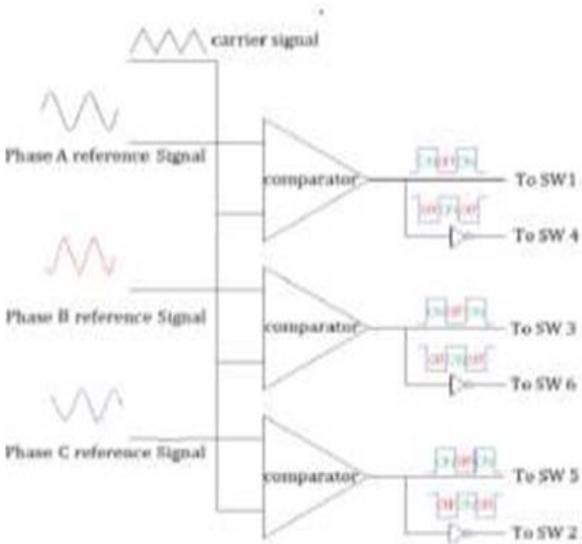


Fig-2.2 Sinusoidal pulse width modulation

B. THIRD HARMONIC INJECTION PWM

The third harmonic injection PWM innovation (THIPWM) was created to enhance the performance of the inverter. THIPWM is an advanced PWM sinusoidal technology that combines 3rd-order harmonic information into the fundamental sinusoidal reference signal (V r). The following waveform is compared to the triangular waveform with a high frequency. The output of the comparator generates signal pulses to trigger inverter switches in the same way as in SPWM. The third harmonic signal amplitude is 1/6 of the reference signal for both the sinusoidal signal. The addition to the sinusoidal relation of the third harmonic contributes to a 15.5% increase in the DC voltage usage rate. The comparator output is employed for controlling the inverter switches exactly as in SPWM inverter. The reference signal consists of fundamental and third harmonic frequency components as following equations.

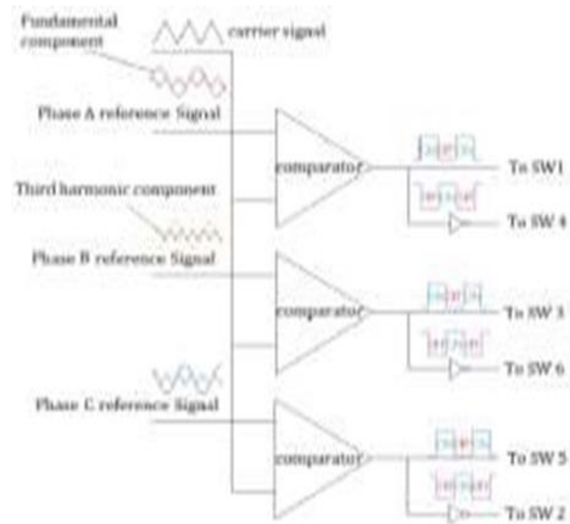


Fig-3.1 Third harmonic injection PWM

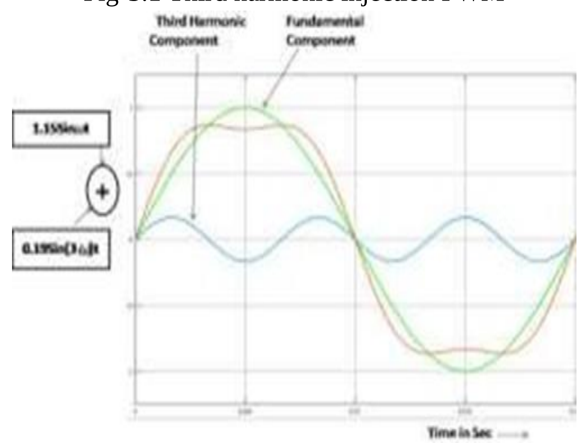


Fig-3.2 Third harmonic injection PWM modulating signal

AMPLITUDE MODULATION INDEX

It's the Ratio of Amplitude of reference Signal to the carrier signal.

Ma=Am/Ac

result

Presented THD ANALYSIS OF VSI with sinusoidal PWM and third harmonic injection PWM.

MATLAB simulation parameters

Switching frequency(fc) = 22 KHz to 18 KHz

Fundamental frequency(f)= 50 Hz

Modulation index (Ma)= 0.5

RL load= 2 KW

DC input voltage = 700 V

AS presented below simulation results of VSI at different carrier frequency (fc) and Modulation index is 0.5 at both PWM techniques.

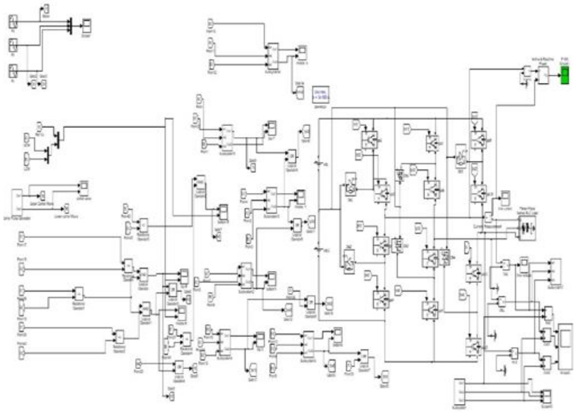


Fig 4.1 Three level npc inverter

(a) VSI outputs at fc= 2 KHz

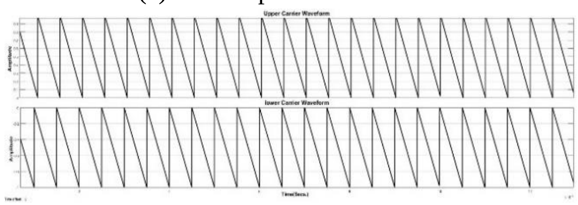
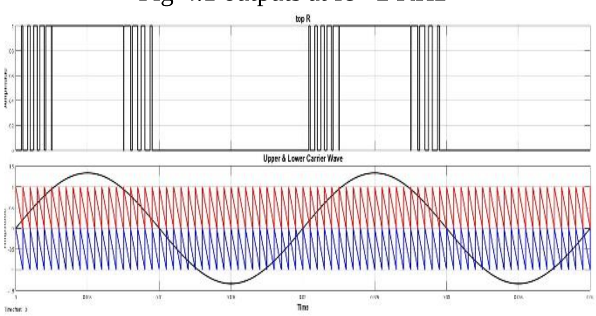
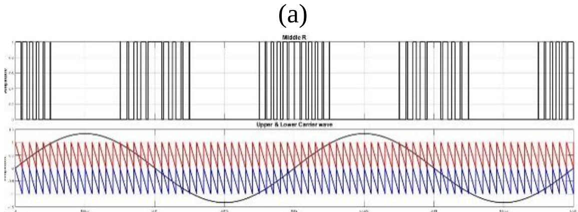


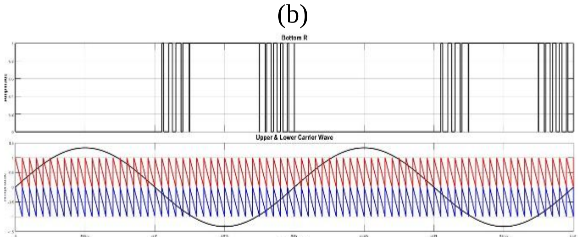
Fig-4.1 outputs at fc= 2 KHz



(a)

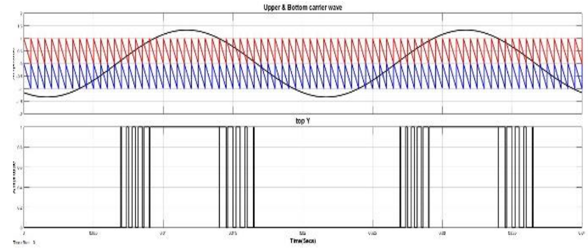


(b)

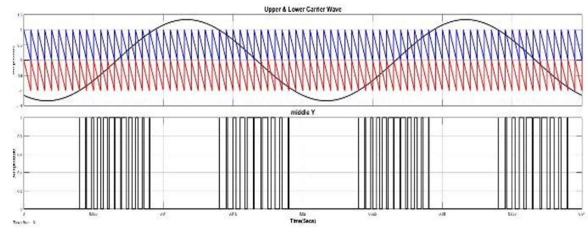


(c)

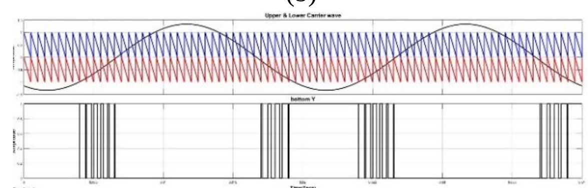
Fig.4.2 Output voltage of (a) top-R (b) middle-R and (c) bottom-R, phase 3 level inverter using NPC at carrier frequency (fc)



(a)

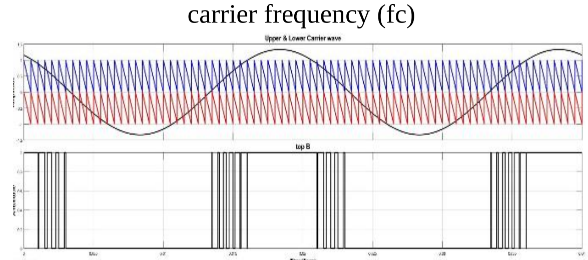


(b)

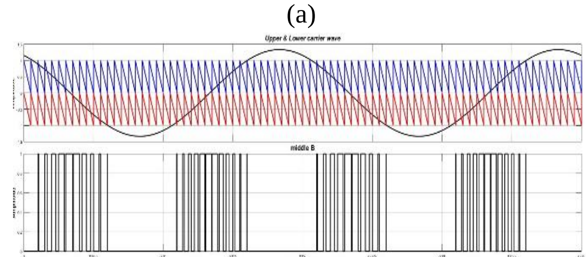


(c)

Fig.4.3 Output voltage of (a) top-Y (b) middle-Y and (c) bottom-B, phase 3 level inverter using NPC at carrier frequency (fc)



(a)



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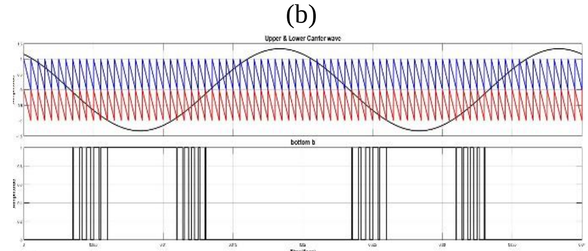


(c)

Fig.4.4 Output voltage of (a) top-B (b) middle-B and (c) bottom-B, phase 3 level inverter using NPC at carrier frequency (fc)

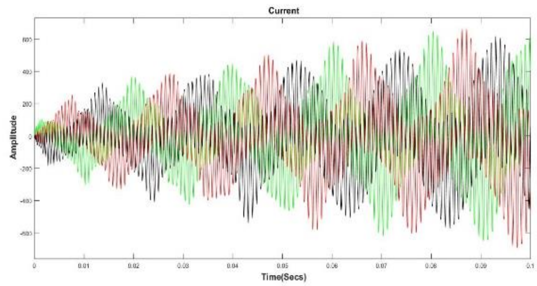


Fig.4.5 Output current of NPC using third harmonic injection PWM at carrier frequency

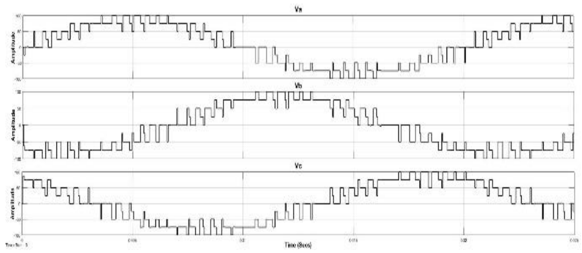


Fig.4.6 Three level output voltage of NPC and 2KHz carrier frequency

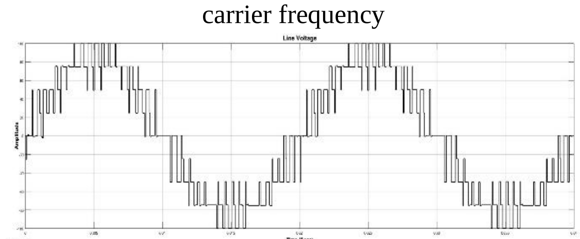


Fig.4.7 Output line-current of three level inverter using third harmonic injection PWM

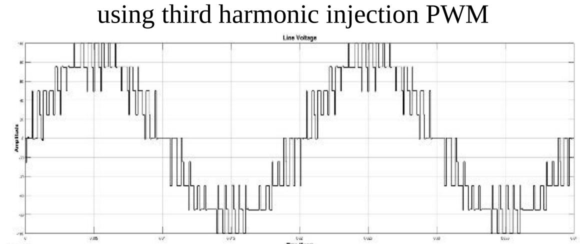


Fig.4.8 Output line-voltage of three level inverter using third harmonic injection PWM

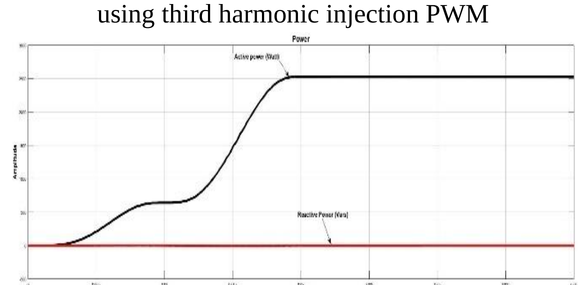


Fig.4.9 Output power of three level inverter using third harmonic injection PWM

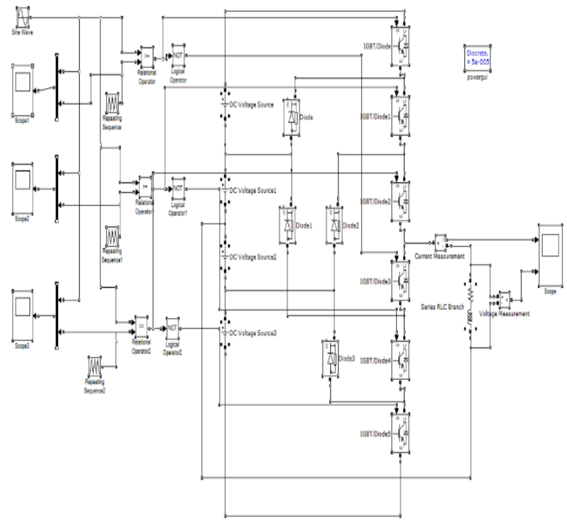
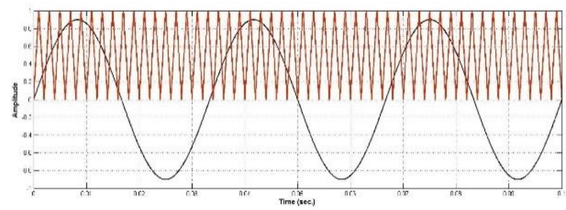
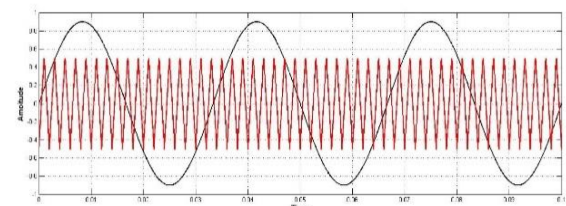


Fig 4.10 Four level Diode-Clamped (NPC) inverter



(a)



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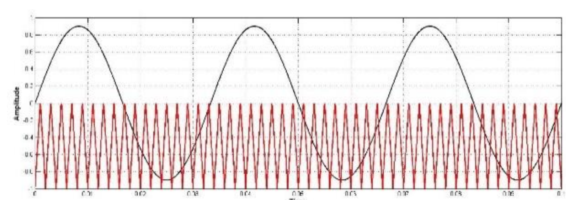

(c)

Fig:4.11 Four level output voltages of (a) Top – R (b) Middle – R (c) Bottom - R

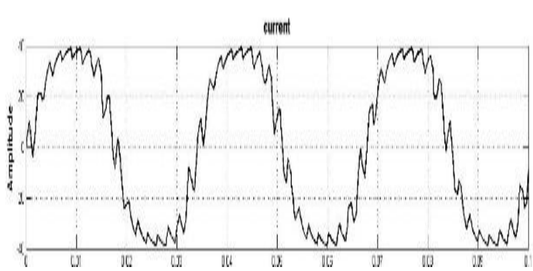

Fig 4.12 four level output current of npc inverter

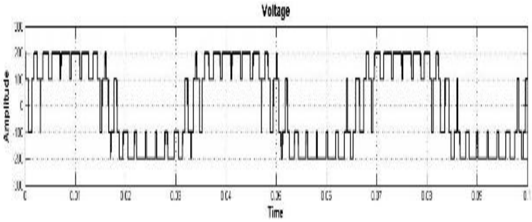

Fig 4.13 four level output current of npc inverter

V.CONCLUSION

With SPWM and THPWM management methods a three-phase VSI has been introduced. We also performed MATLAB Simulink and FFT analysis for different carrier frequency values. FFT VSI output current THD analysis is carried out on 2KHz to 18KHz holding frequencies and the modulation index is 0.5. From simulation results, THD is decreasing in both techniques for the output current with increasing carrier frequency. THIPWM is concluded to give lower THD than SPWM with increasing carrier frequency in three-phase inverter output today. The output of THIPWM is better than that of the SPWM. It has clearly shown that by varying carrier frequency from low to high value we can minimize the THD of phase currents.

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REFERENCES

[1] G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. (references)

[2] Electricity and Magnetic fields thesis, J. Clerk Maxwell, third ed., vol. 2. Oxford, pp. 68-73, Clarendon, 1892.

[3] "Fine particles, thin films, and exchange anisotropy," in Magnetism, vol. III, Eds. G. T. Rado, and H. Suhl, New York: Academic, 1963, pp. 271–350. I. S. Jacobs and C. P. Bean, "Fine particles, thin films, and exchange anisotropy," in Magnetism, vol. III, Eds. G. T. Rado, and H. Suhl, New York:

[4] K. Elissa, "Title of paper if known," unpublished.

[5] F. Gonzalez-Espin, G. Garcera, Ivan Patrao "An adaptive control system for three-phase photovoltaic inverters working in a polluted and variable frequency electric grid", IEEE Transactions on Power electronics, Vol. 27, no. 10, pp. 4248–4261, October 2012.

[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] J. Amini and M. Moallem, "A Fault-Diagnosis and Fault-Tolerant Control Scheme for Flying Capacitor Multilevel Inverters", IEEE Transactions on industrial electronics, Vol. 64, no.3, pp. 1818-1826, July 2016.

[8] R. H. Baker and L. H. Bannister, "Electric power converter," U.S. Patent 3 867 643, Feb. 1975.

[9] Barker, Richard H., "Bridge converter circuit," U.S. Patent 4 270 163, May 1981.

[10] C. Attaianese, M. Di Monaaco, and G. Tomasso, "Three-Phase Three-Level Active NPC Converters for High Power Sysyem", International Symposium on Power Electronics, Electrical Drives, Automation and Motion, pp.204-209, June 2010.

[11] Baoming Ge, Fang Zheng Peng, Anibal T. de Almeida, and Haitham Abu-Rub, "An Effective Control Technique for Medium-Voltage High Power Induction Motor Fed by Cascaded Neutral-Point-Clamped Inverter", IEEE Trans on Industrial Electronics, Vol.57, No. 8, pp.2659-2668, Aug 2010.

[12] Jun Li, Subhashish Bhattacharya, and Alex Q. Huang, "A New Nine-Level Active NPC (ANPC) Converter for Grid Connection of Large Wind Turbines for Distributed Generation", IEEE Trans on Power Electronics, Vol.26, No.3, pp.961-972, March 2011.

[13] Bin Wu, “High Power Converter and AC Drives” IEEE Press, Wiley Inter science, A John Wiley &Sons, Inc., Publication., Page No.: 119-178.
[14] Byeong-Mun Song, Junhyung Kim, Jih-Sheng Lai, Ki-Chul Seong, Hae-Jong Kim, and Sun-Soon Park,”A Multilevel Soft-Switching Inverter with Inductor Coupling”, IEEE Trans. On Industry Applications, Vol.37, NO. 2, pp.628-636, March/April 2001.
[15] Pavel Kobrle, Jiri Pavelka, “Analysis of Permissible State of Flying Capacitors Multilevel Inverter Switch”, 14th International Power Electronics and Motion Control Conference, pp. T3-42-T3-45, Oct.2010.
[16] Anshuman Shukla, Arindam Ghosh, and Avinash Joshi, “Static Shunt and Series Compensations of and SMIB System Using Flying Capacitor Multilevel Inverter”, IEEE Trans. On Power Delivery, Vol.20, No.4, pp.2613-2622, Oct 2005.
[17] J. Sen and N. Butterworth, “Analysis and Design of a Three-Phase PWM converter System for Railway Traction Applications”, IEE Proceedings on Electrical Power Applications, Vol. 144, No. 5, pp.357-371, 1997