International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075, Volume-8 Issue-2S2 December, 2018

Constant Flux Control N-level Drive Pplication for Industries

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***Abstract:** The two level conventional converters are slowly substituted by multilevel converters because of mitigated THD and stress reduction on power semiconductor switch. The rigorous survey performed on various industrial applications using variable speed drive with 2-level and N-level inverter lies in selecting the topology and control methods. For different applications, one control method may be suitable to avail good characteristics. In this paper, the techniques SPWM and SVPWM applied on 9-level diode clamped N-level inverter operated induction machine are compared for various industrial applications. The analysis concludes: For speed control and at high and normal MI, SPWM is preferable and at low and normal mi values, SVPWM is preferred in constant V/f method of induction machine.*

***Index Terms:** SPWM, SVPWM, SCMM, MCMM.*

I. INTRODUCTION

A constant flux drive is used in various ac drives to control speed and torque by varying applied frequency and applied voltage. The CFD is a Variable Speed Drive-VSD, consist a diode rectifier and an inverter. Primary benefit of CF drive is increased energy efficiency. Power utilization of a variable speed drive at lowspeeds is less compared to a motor speed controlled by valves running at less than full speed. Constant flux drive is programmable for smooth starting by reducing transients in torque, which is normally in the range of 160%. Fig. 1 is an AC variable speed drive with 3ΦAC source, rectifier, dc link, N-level inverter and an induction motor driving a load.Progressive fields of power electronics enables induction motors usage for high-performance drives because of rugged construction, affordable rate, good performance characteristics, commutator free operation, and good speed control compared to DC motor. Most of the loads operate based on constant ratio of Volts to Hertz control technique because of its simple operation. If the air gap flux is small, the core properties cannot be utilized and cannot output good and if the magnetic flux is very large, the iron core saturates, leading to an excessive exciting current and motor may even fail to operate. This leads to operate the motor within the limits of constant air-gap flux. This paper considers constant flux control conventional 9-level DCMLI driven induction motor run with SPWM and SVPWM control techniques.

Revised Manuscript Received on December 08, 2018.
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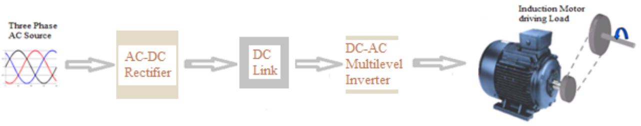

Fig. 1 Variable Speed Drive

II. DIODE CLAMPED MULTILEVEL INVERTER AND MODULATING TECHNIQUES

A. Multilevel Converter Topologies

Three basic multilevel converters are: Diode clamped, flying capacitor and Hybrid multilevel inverter. In a conventional DCMLI topology per a phase leg, each switching device or diode or capacitor's voltage is 1Vdc, i.e., 1/(N-1) of DC link voltage.

A. Modulation Techniques

The three PWM methods to generate pulses for MLIs are:

1. Multilevel SPWM: Sine and Triangle Carrier compared Pulse Width Modulation
2. Multilevel SFOPWM: Sub frequency optimal PWM
3. SVPWM- Space Vector Pulse Width Modulation based on vector rotating in multilevel space

SPWM control technique proposed by Carrara for multilevel inverter employ comparison of reference-sinusoidal signal with level and phase shifted carrier signals to generate PWM signal. Carrier PWM techniques are operated at high switching frequency to offer high quality waveform for applications.

The Programmable SVPWM technique involves optimizing reference voltage vector with nearest voltage space vectors. SVPWM provides

(i) Improved fundamental output voltage
(ii) Reduced harmonic distortion
(iii) Easier implementation with Digital Signal Processors

B. Constant V/f control of induction machine

Open loop constant V/f control of the machine provide a satisfactory operated VSD, when the motor needs to operate at steady torque without stern requirements on speed regulation.

III. RESULTS AND DISCUSSIONS

The simulation model for 9-level DCMLI is developed for SPWM and SVPWM technique. The results are presented for various MIs for a motor of 30kW, 400V, 4 pole, 1470rpm with switching frequency of 1500 Hz.

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SVPWM is simulated for CSS-conventional switching sequence and OSS-optimized switching sequence for MCMM-multicarrier multi-modulation and SCMM-single carrier multi-modulation technique.

Table1 shows at various instants how SPWM and SVPWM respond to different torque and speed requirements.

Fig. 2 to Fig. 6 show the response of industrial application induction machine for various control techniques and for parameters I_S-stator currents, T_e-electromagnetic torque and ω_r-rotor speed. Fig. 2 presents the response of SPWM control mode. Fig. 3 and Fig. 4 represent response for conventional switching sequence and Fig. 5 and Fig. 6 for optimized switching sequence for SVPWM technique. Fig. 3 and Fig. 5 are for MCMM mode and Fig. 4 and Fig. 6 are for SCMM mode.Submit your manuscript electronically for review.

TABLE 1: CFC CONTROL PARAMETER VALUES FOR SPWM AND SVPWM

Parameter	SPWM	SVPWM
t- time	[0 .4 .8 1.2 1.6 2 2.4 2.8]	[0 .4 .8 1.2 1.6 2 2.4 2.8 3.2]
MI-modulation index	[0.11 0.31 0.5 0.5 0.52 0.58 0.41 0.21]	[0.275 0.5325 0.866 0.866 0.866 0.778 0.618 0.45 0]
f-frequency	[10 30 50 60 50 -50 -40 20]	[10 30 50 70 90 -45 -35 25 0]
T-Torque	[10 50 80 20 50 70 -50 -40]	[100 100 190 100 50 150 -120 -150 0]

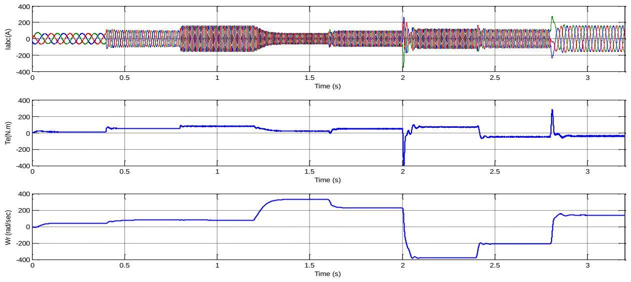

Fig. 2I_S, T_e and ω_r for SPWM

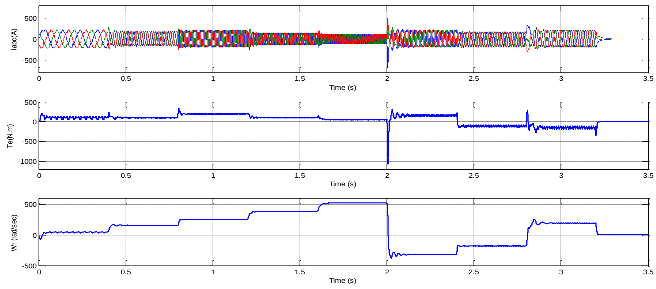

Fig. 6 OS SCMM I_S, T_e and ω_r

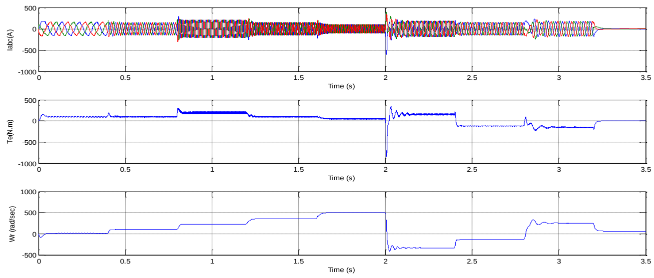

Fig. 3 CS MCMM I_S, T_e and ω_r

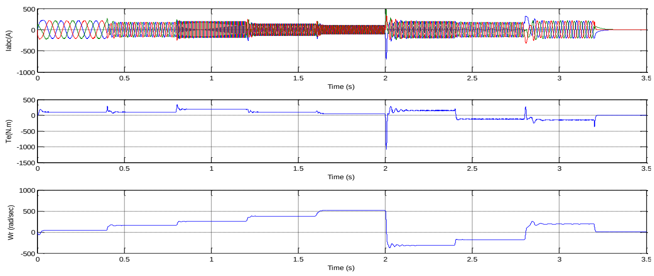

Fig. 4 CS SCMM I_S, T_e and ω_r

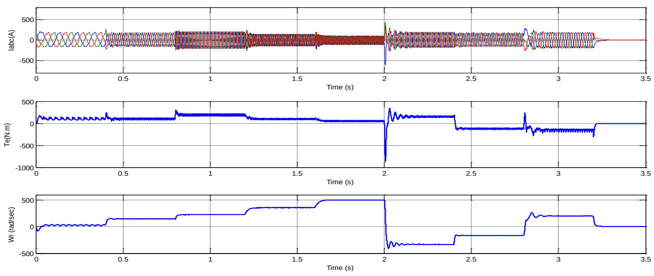

Fig. 5 OS MCMM I_S, T_e and ω_r

TABLE 2: VOLTAGE AND CURRENT THD OF SPWM, AND SVPWM TECHNIQUES

	SPWM	SVPWM			
		CS-MCMM	CS-SCMM	OS-MCMM	OS-SCMM
Voltage THD	16.87	10.94	7.09	11.90	9.01
Current THD	1.17	4.79	0.88	6.22	5.75

Table 2 presents voltage and current THD for SPWM and SVPWM techniques.

IV. CONCLUSION

SVPWM allow operation at “low and normal” mi, however SPWM allow for normal and over mi. In all the techniques, at low MIs THD is more with low order harmonics existence because of instant inequalities among the dc sources. SVPWM response to load requirement is good. Conventional switching sequence or optimized switching sequence SCMM works for low MIs however MCMM do not. The CS-SCMM shows improved linearity in output wave with high fundamental component of voltage compared to MCMM. The OS method improved response in output voltage for MCMM compared to CS-MCMM even at low MI of 0.1. In both MCMM and SCMM the harmonic distortion decreases as mi increases from “low to normal”

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value. For same region, number of switching states is reduced to 8/10 with optimized sequence compared to conventional sequence. Torque ripple is less in SVPWM. Steady state reach time is more in SVPWM due to complexity in calculations. Reduced THD is observed in MCMM, SCMM conventional and OSS- SVPWM compared to SPWM.

Highlights

- Programmable control techniques-SVPWM, improved the performance of induction machine
- The optimized switching sequence reduce the switching losses compared to conventional
- Single carrier multi-modulation technique reduced harmonic distortion

REFERENCES

1. Chookiat Nitayotan, Woravit Tearwattanarattikal, Surapong Suwankawin, Somboon Sangwongwanich: Enhancement of the Performance of General-Purpose V/F Inverters with Automatic Torque Boost and Automatic Adjustment Method of Acceleration/Deceleration Times, The 2005 International Power Electronics Conference, pp. 390-397.
2. Subrata K.Mondel, Bimal K.Bose, Valentine Oleschuk: Space Vector Pulse Width Modulation of Three-Level Inverter Extending Operation into Overmodulation Region, IEEE Transactions on power Electronics, Vol. 18, No. 2, Mar 2003, pp. 604-611.
3. Nguyen Van.Nho, Quach Thanh Hai, Hong Hee Lee: Carrier based Single State PWM Technique in Multilevel Inverter, International Symposium on Electrical & Electronics Engineering, pp. 231-239, Oct 24,25, 2007.
4. A. Nabae, I. Takahashi, and H. Akagi: A New Neutral-Point Clamped PWM Inverter, Proceedings of the Industry Applications Society Conference, pages 761-766, September/October 1980.
5. Abdul Rahiman Beig, G.Narayanan, V.T. Ranganathan: Space Vector Based Synchronized PWM Algorithm for Three Level Voltage Source Inverters: Principles and Application to V/f Drives, IECON 02, Industrial Electronics Society, IEEE 2002 28th Annual Conference Vol. 2, pp. 1249-1254.
6. Rathinam Angamuthu, Karthikeyan Thangavelu, Ramani Kannan: Reduction of Components in New Family of Diode Clamp Multilevel Inverter Ordeal to Induction Motor, Journal of Semiconductor Technology and Science, Vol.16, No.1, February 2016.
7. A.R.Shelar, S.M.Chaudhari: Speed Control of 3 Phase Induction Motor by using Multilevel Inverter, International Journal of Innovative Research in Advanced Engineering, Vol.1, No.12, pp.61-68, Dec2014.
8. S.Kiruthika, S.Sudarshan, M.Murugeshan, B.Jayamanikandan: High Efficiency Three Phase Nine Level Diode Clamped Multilevel Inverter, International Journal of Science and Research, Vol.1, Issue.3, December 2012, pp.120-123.
9. Abhay Kumar, Vinay Kumar Tripathi: Performance & Analysis of Grid Connected Renewable Energy System with Multilevel NPC Inverter, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, Vol. 4, Issue.6, pp.305-311, May 2016.
10. D.Surendar Arnepalli, Ch.Srinivas: Nine Level Inverter for Speed Control of Induction Motor using SPWM Technique, Global Journal of Advanced Engineering Technologies, Vol2, Issue 4, pp. 259-263, 2013.
11. N. Mohan Teja, R.S. Ravi Sankar, P. Harsha, V. Uma Shankar: A Novel Method of Diode Clamped Multi-Level Inverter using PWM Technique,International Journal of Innovative Engineering and Sciences, Volume 2, Issue 4, pp.9-12, Mar 2014.
12. www.google.com (part of Fig. 1)

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