Modulation Scheme of Multilevel inverter

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Abstract:

In this research article modulation scheme of multilevel inverter (MLI) is presented. This focuses on factors affecting switching criterion and selection of reference signal and carrier waveform. 2-Level PWM is taken to know the mathematical modelling for selection of modulation technique.

Introduction:

Multilevel inverters are used for the smoother output power, with this capability research were carried out by scholars to enhance the capability of two-level multilevel modulation to multilevel. Modulation scheme formulation depends on input electrical parameters and change in output parameters to be derived i.e. voltage/ frequency control. With increase in number of operational level, inverters working become more complex and this complexity open a new era of designing for problem specific inverter topologies. These new topologies are unique in operation and working figure 1, shows classification of modulation schemes.

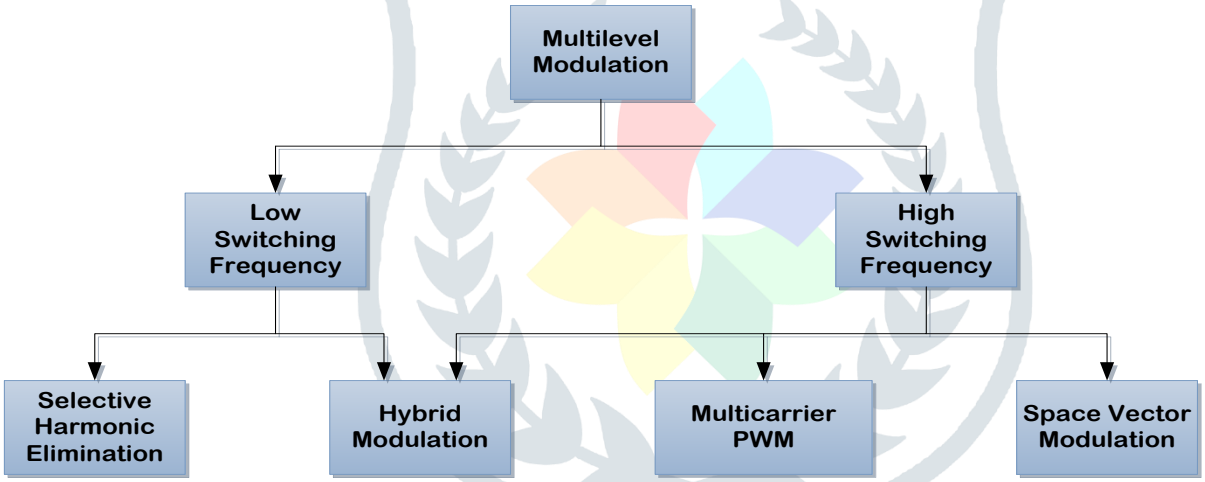

Figure 1 Classification of multilevel modulation methods

Modulation Schemes Popularly Used:

Commonly used Modulation schemes as per literature review are as follows:

1. Carrier on PWM based

2. Selective Harmonic Elimination (SHEV)

3. Space Vector PWM (SVM)

- **Carrier based PWM:**

  With this technique output harmonic distortion is reduced via comparing reference sinusoidal signal with triangular carrier signals.

- **Selective Harmonic Elimination (SHE):**

  In this Fourier analysis is used for low switching frequency so that switching angels to be adjusted for the reduction of harmonics in the output.

- **Space Vector PWM (SVM):**

  In Space Vector Modulation (SVM) algorithm, space vector of three phase control the switching of inverter.

2-LEVEL PWM

This research utilised 2-level PWM technique for multilevel modulation. Where figure 2 shows 2-level PWM where sinusoidal reference waveform is compared with carrier signal usually triangular waveform.

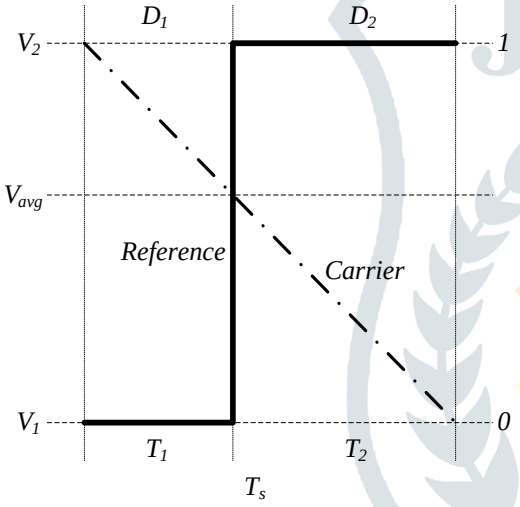

Figure 2. Basics of 2-level PWM

Based on this figure, if we assume that the average output voltage in switching cycle T_s is V_{avg} we have:

$$T_1V_1 + T_2V_2 = T_SV_{avg} \quad (4.1)$$

And,

$$T_1 + T_2 = T_SV_{avg} \quad (4.2)$$

Where

T_1: switching time where the reference signal is lower than the carrier.

V_1: minimum voltage and is generated by subtraction of reference and carrier signals when the reference is lower than carrier.

T_2: switching time where the reference signal is higher than the carrier and

V_2: maximum voltage and is generated by subtraction of reference and carrier signals when the reference is higher than carrier.

There are different methods of modulation for this selection there are some salient points to be taken care while selection of signal and carrier.

- Carrier signal is usually a symmetric triangular wave, but a saw tooth wave can be used either. Important fact is that the symmetric signal generates fewer harmonic.
- The reference signal can be continuous or sampled synchronous with carrier signal. The second method usually generates fewer harmonics. Since today digital controllers are used, this method is preferred.

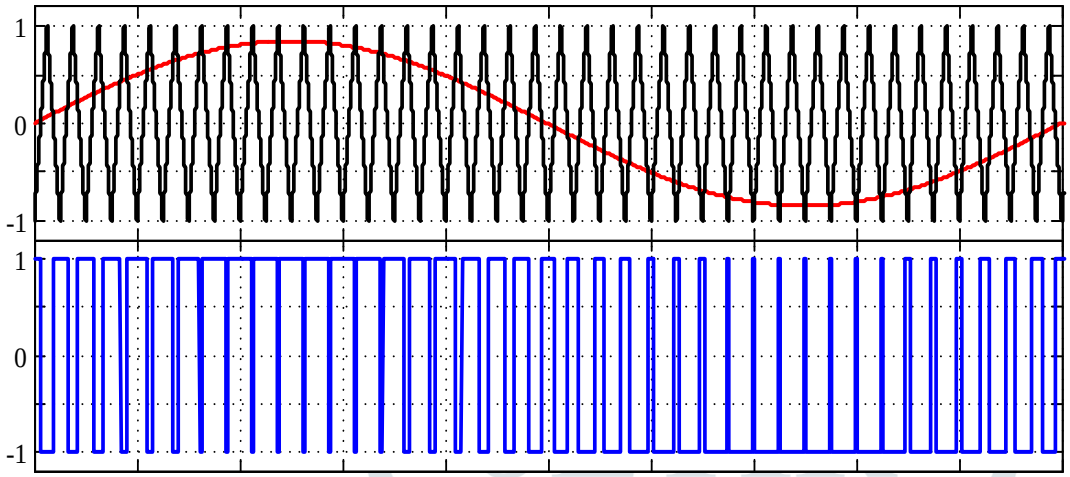

Figure 3. Carrier and reference waveform of 2-level PWM

Conclusion: In this research work modulation topology of MLI is discussed. Along with this essential steps to generate switching signal were also taken. 2-level PWM technique and its carrier reference waveform plot is mentioned. This research is utilized for understanding of the selection of reference waveform in modulation technique of MLI.

REFERENCES

[1] Pregelj, A.; Begovic, M.; Rohatgi, A. "Impactt of inverter configuration on PV system reliability and energy production," Photovoltaic Specialists Conference, 2002. Conference Record of the Twenty-Ninth IEEE , vol., no., pp. 1388- 1391, 19-24 May 2002

[2] Jih-Sheng Lai; Fang ZhengPeng; "Multilevel converters-a new breed of power converters," Industry Applications Conference, 1995. Thirtieth IAS Annual Meeting, IAS '95., Conference Record of the 1995 IEEE , vol.3, no., pp.2348-2356 vol.3, 8-12 Oct 1995.

[3] Rodriguez, J.; Jih-Sheng Lai; Fang ZhengPeng; "Multilevel inverters: a survey of topologies, controls, and applications," Industrial Electronics, IEEE Transactions on, vol.49, no.4, pp. 724- 738, Aug 2002.

[4] Rodriguez, J.; Franquelo, L.G.; Kouro, S.; Leon, J.I.; Portillo, R.C.; Prats, M.A.M.; Perez, M.A.; , "Multilevel Converters: An Enabling Technology for High-Power Applications," Proceedings of the IEEE , vol.97, no.11, pp.1786-1817, Nov. 2009.

[5] Malinowski, M.; Gopakumar, K.; Rodriguez, J.; Pérez, M.A. "A Survey on Cascaded Multilevel Inverters," Industrial Electronics, IEEE Transactions on, vol.57, no.7, pp.2197-2206, July 2010.

[6] Panagis, P.; Stergiopoulos, F.; Marabeas, P.; Manias, S. "Comparison of state of the art multilevel inverters," Power Electronics Specialists Conference, 2008. PESC 2008. IEEE, vol., no., pp.4296-4301, 15-19 June 2008.

[7] Tolbert, L.M.; Fang ZhengPeng; Habetler, T.G. "Multilevel converters for large electric drives," Industry Applications, IEEE Transactions on, vol.35, no.1, pp.36-44, Jan/Feb 1999.

[8] Fang ZhengPeng; , "A generalized multilevel inverter topology with self voltage balancing," Industry Applications, IEEE Transactions on , vol.37, no.2, pp.611-618, Mar/Apr 2001.

[9] Teodorescu, R.; Blaabjerg, F.; Pedersen, J.K.; Cengelci, E.; Enjeti, P.N.; , "Multilev cascading industrial VSI," Industrial Electronics, IEEE Transactions on , vol.49, no.4, Aug 2002.

[10] Nabae, Akira; Takahashi, Isao; Akagi, Hirofumi; , "A New Neutral-Point-Clamped PWM Inverter," Industry Applications, IEEE Transactions on , vol.IA-17, no.5, pp.518-523, Sept. 1981

[11] T. A. Meynard and H. Foch, "Multi-level choppers for high voltage applications," in Proc. Eur. Conf. Power Electron. Appl., 1992, vol. 2, pp. 45–50.

[12] M. Marchesoni, M. Mazzucchelli, and S. Tenconi, "A non-conventional power converter for plasma stabilization," in Proc. Power Electron. Spec. Conf., 1988, pp. 122–129.

[13] De, S.; Banerjee, D.; Siva Kumar, K.; Gopakumar, K.; Ramchand, R.; Patel, C.; , "Multilevel inverters for low-power application," Power Electronics, IET , vol.4, no.4, pp.384-392, April 2011.