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Three Phase Multi-Level Inverter Topologies and Modulation Techniques

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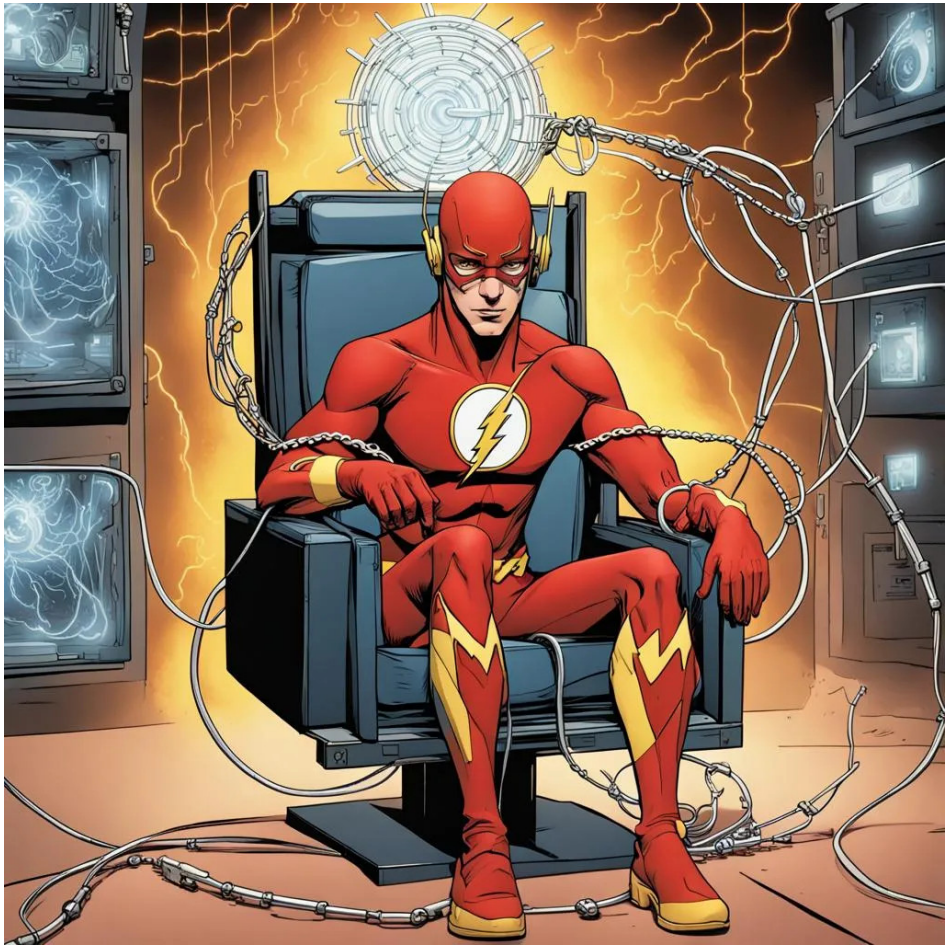


Abstract

- To mention the vital role of power electronic converter in the power production domain
- The paper reveiews methodologies to control **three-phase multi-level Inverter** by PWD control techniques
- Proposal **three-phase multi-level Inverter topologies** and **Modulation Techniques**
- comparison among PWM control techniques **phase disposition (PD)**, **phase opposite disposition (POD)**, and **alternate phase opposite disposition (APOD)**
- Analysing **THD** and **common mode** between methodologies

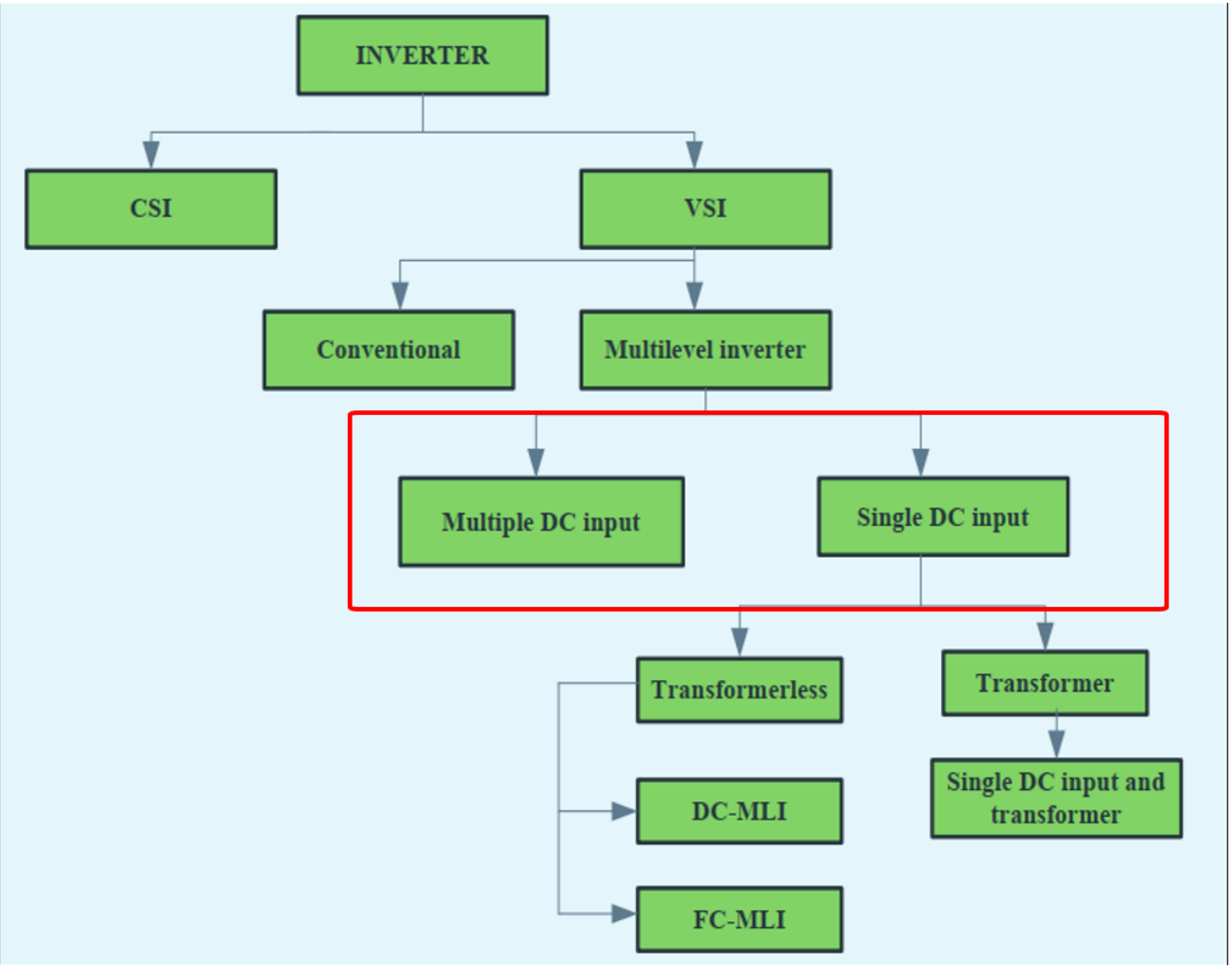
Reference Papers

- Anup Kumar Panda and Yellasiri Suresh, “Research on cascaded multilevel inverter with single DC source by using three-phase transformers,” Electrical Power and Energy Systems. no 40, pp. 9–20, 2012.
- Bendre A, Krstic S, Meer JV and Venkataramanan G., “Comparative evaluation of modulation algorithms for neutral point clamped converters,” IEEE Trans Ind Appl 2005;41:634–43.
- Colak I, Kabalci E and Bayindir R., “Review of multilevel voltage source inverter topologies and control schemes,” Energy Convers Manag 2011; 52:1114–28.
- Anup Kumar Panda.: Yellasiri Suresh.: Research on cascaded multilevel inverter with single DC source by using three-phase transformers. Electrical Power and Energy Systems. no 40, pp. 9–20, 2012.
- Suresh.Y., Panda A.K.: Research on a cascaded multilevel inverter by employing three-phase transformers. IET Power Electron., Vol. 5, no. 5, pp. 561–570, 2012
- R. Gonzalez, E. Gubia, J. Lopez, and L. Marroyo, “Transformer less single phase multilevel-based photovoltaic inverter,” IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2694–2702, Jul. 2008

Review Objective

- Three-Phase multi-level Inverter
  - Diode clamped Inverter
  - Flyting capacitor Inverter
  - Cascaded H-Bridge Inverter
- Single DC source with single phase transformer H-Bridge (topology 1)
- Single DC source with single phase transformer H-Bridge (topology 2)
- Modulation techniques
  - phase disposition (PD)
  - phase opposite disposition (POD)
  - alternate phase opposite disposition (APOD)

Introduction about three-Phase Inverter



Introduction about three-Phase Inverter

- The three-phase converter include voltage source Inverter (VSI) and current source Inverter (CSI)
- voltage source Inverter (VSI)
  - fundamental three-phase Inverter with 2 level
  - multi-level three-phase Inverter (3, 5, or 7 level)

Three-Phase multi-level Inverter with Diode clamped Inverter

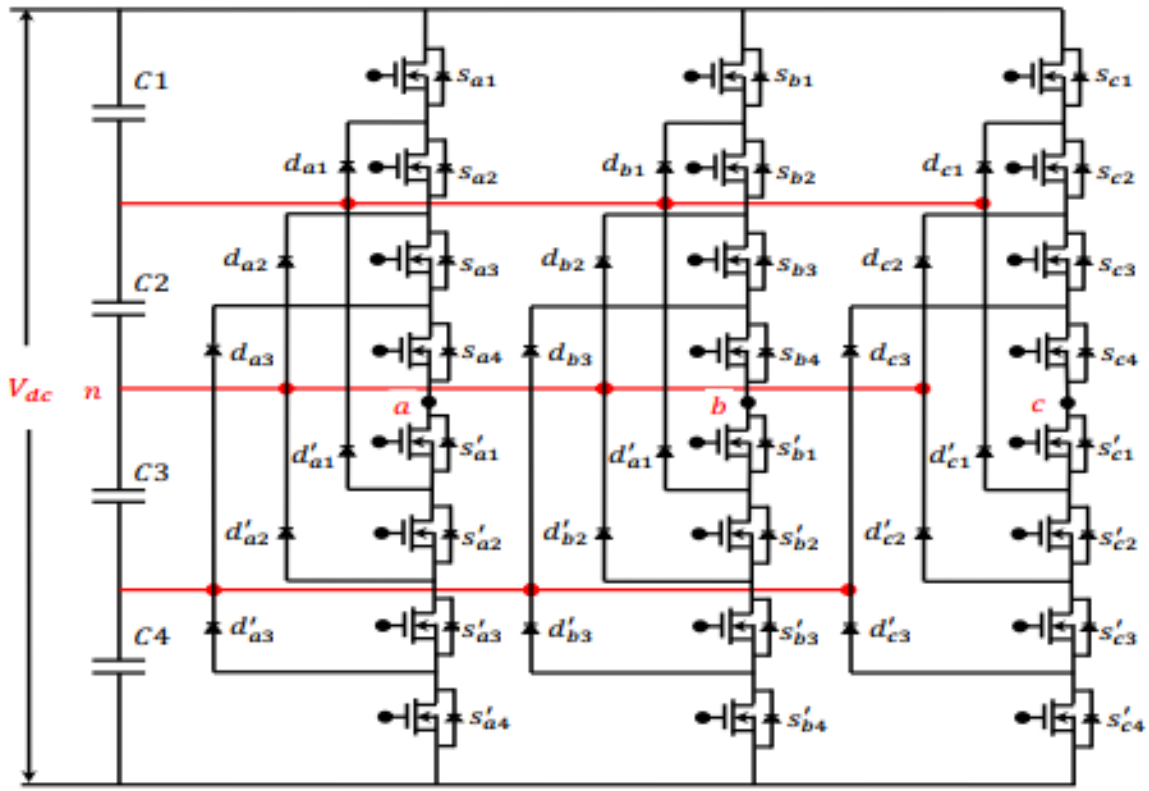


Fig. 2. Diode clamped inverter

Three-Phase multi-level Inverter with Diode clamped Inverter

- three phase multi-level 5 steps using diode clamped Inverter
- Using single source DC and containing DC bus voltage with 4 capacitor C1, C2, C3, and C4
- Each capacitor have one supply voltage and single capacitor voltage is limited by the voltage stress from switches
- using cascaded diodes to connect from switches S' to S

Three-Phase multi-level Inverter with Flyting capacitor Inverter

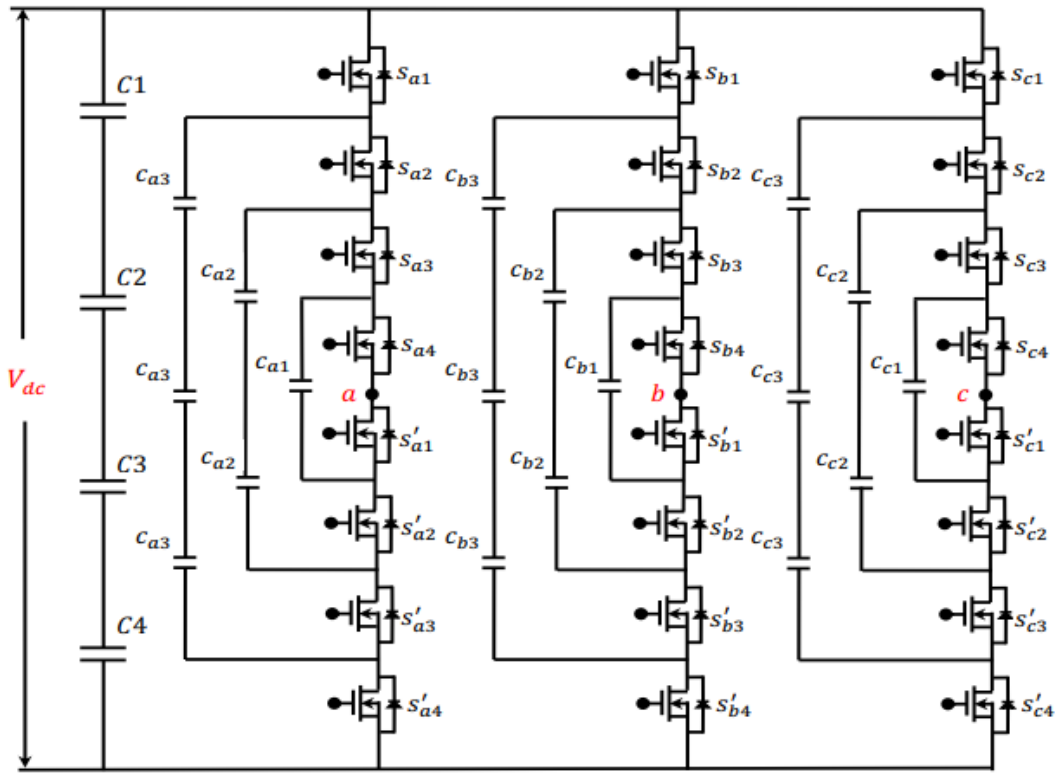


Fig. 3. Flying capacitor inverter

Three-Phase multi-level Inverter with Flyting capacitor Inverter

- three phase multi-level 5 steps using Flyting capacitor Inverter
- Using single source DC and containing DC bus voltage with 4 capacitor C1, C2, C3, and C4
- Each capacitor have one supply voltage and single capacitor voltage is limited by the voltage stress from switches
- using cascaded capacitor to connect from switches S' to S

Multiple DC sources with H-Bridge Inverter

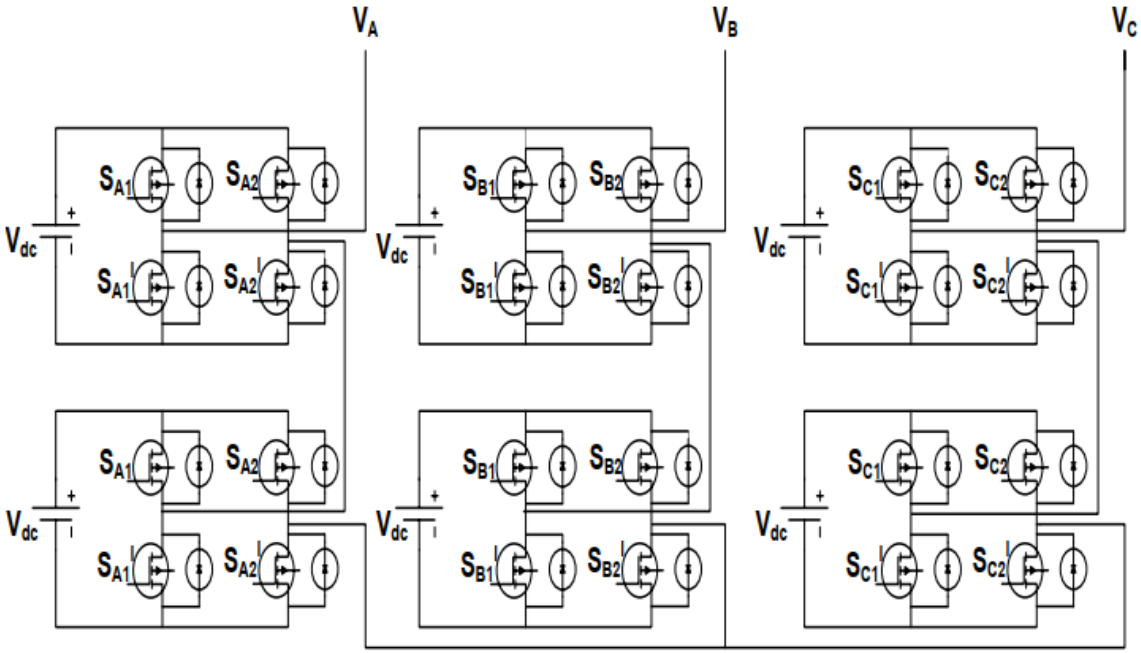


Fig. 4. Cascaded H-Bridge Inverter

Multiple DC sources with H-Bridge Inverter

- Using Multiple DC source for each full-Bridge Inverters
- containing 6 full-Bridge Inverters that divide to three level
- The cascaded level 1, 2, and 3 corresponding with phase A, B, and C respectively
- The drawback of Multi-DC source H-Bridge Inverter is using a lot of DC source

Single DC source with single phase transformer H-Bridge (topology 1)

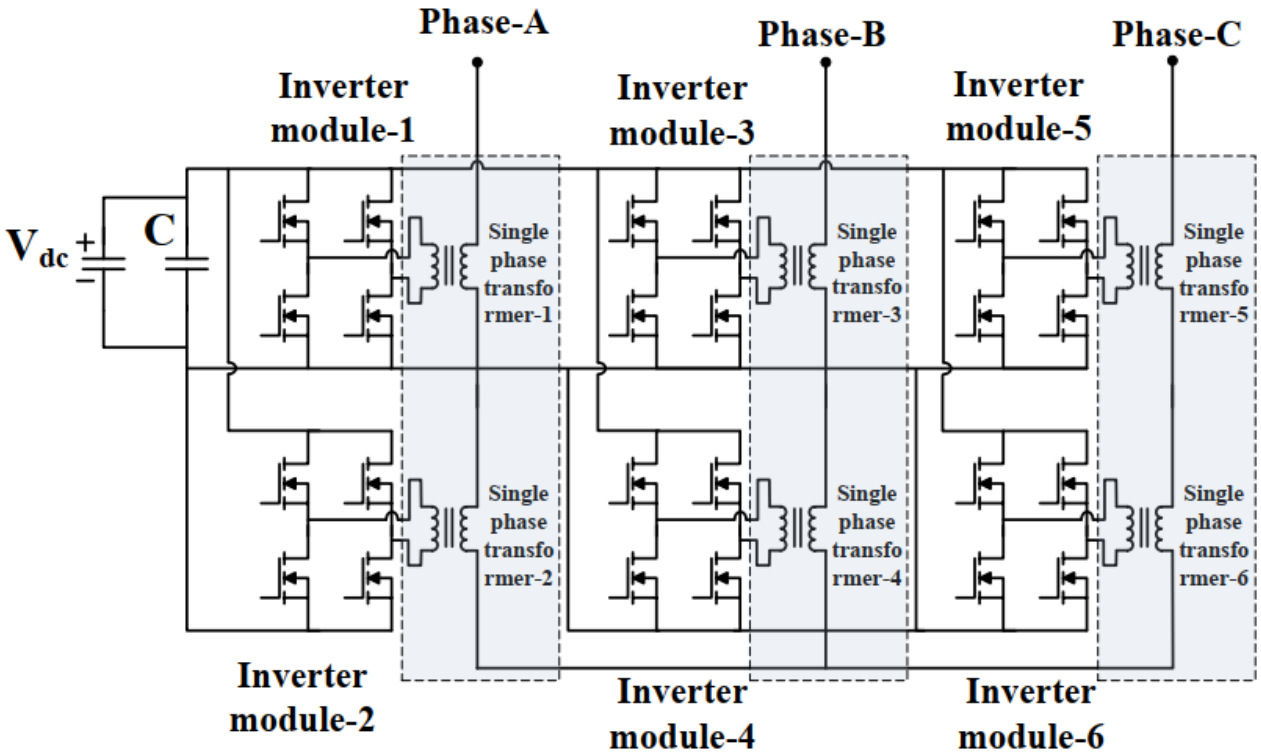


Fig. 5. Single DC source with single-phase transformers H-Bridge (Topology 1)

Single DC source with single phase transformer H-Bridge (topology 1)

- Using only one DC source for a System
- transformers are imported between levels to gain amplification of output signal
- The cascaded level 1, 2, and 3 corresponding with phase A, B, and C respectively
- the benefit of this System is using only a single DC source

Single DC source with single phase transformer H-Bridge (topology 2)

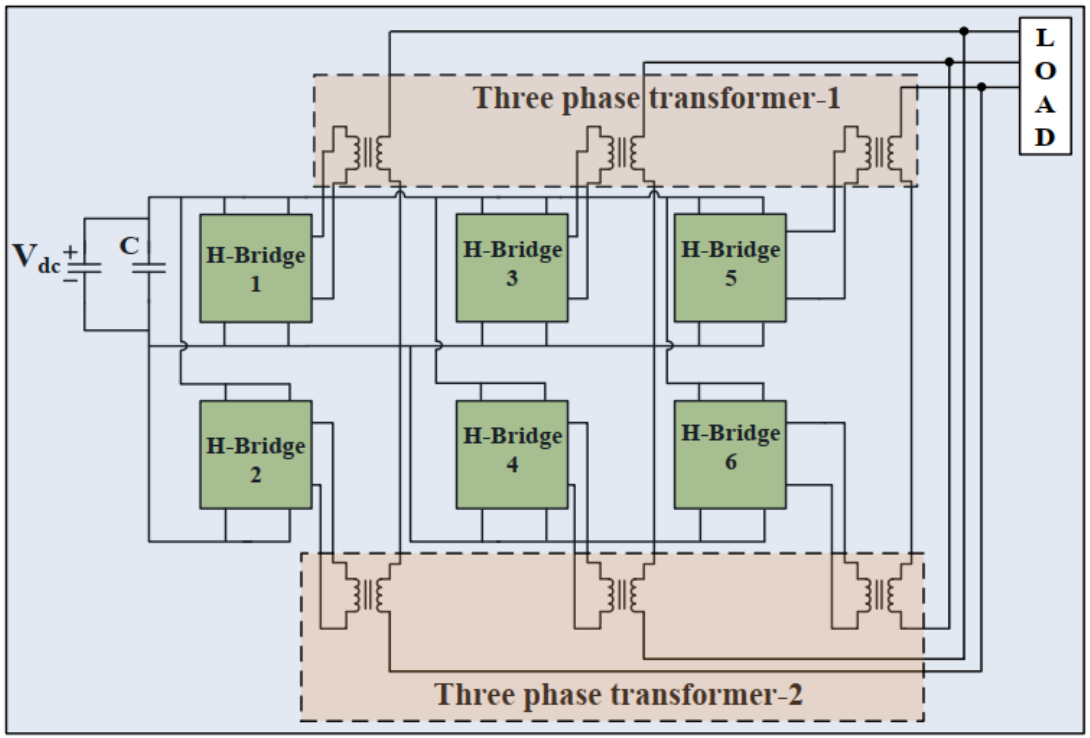


Fig. 6. Single DC source with three-phase transformer H-Bridge (Topology 2)

Single DC source with single phase transformer H-Bridge (topology 2)

- Using only one DC source for a System
- transformers are imported between levels to gain amplification of output signal
- The cascaded level 1, 2, and 3 corresponding with phase A, B, and C respectively
- Three phase transformer 2 (below) is connected directly to LOAD
- in terms of increasing voltage level by connecting the second terminal of the transformer 2 to ouput LOAD that is the advantage of topology 2 comparing with topology 1

Modulation techniques

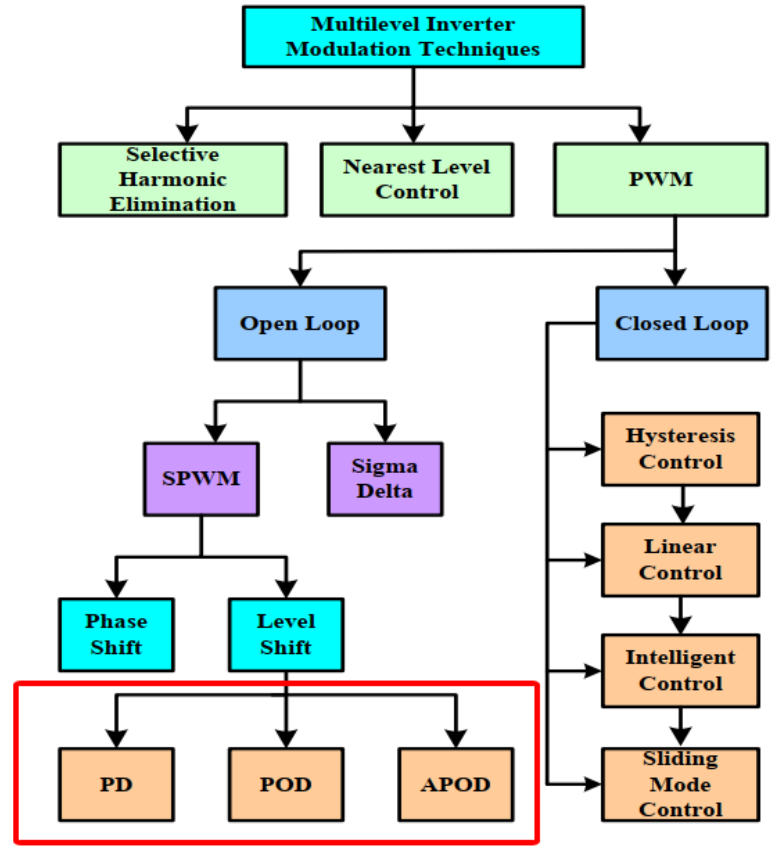


Fig. 9. PWM techniques and control methods

Modulation techniques

- We forcus on three methods using PWD control level shift
  - **PD:** this method reduces dramatically THD of the three-phase multi-level Inverter. However, the drawback of this method increases common mode.
  - **POD and APOD:** By the Contrast, both methodologies will increase THD and reduce the common mode

Diode clamped Inverter

Content

Content

Thanks for your attention

Presentation: Huan Nguyen-Duy