Modulation of multilevel converters based on analytical methods

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Multilevel Converters (MLC) are gaining popularity in many areas of energy conversions including Renewable Energy Systems, Distributed Generation, Smart Grids, E-Transportation, Electrical Drives for Industry.
Distinctive features of multilevel converters are their capability to overcome the voltage limits imposed by the adopted power devices (IGBT, MOSFET) and their capability to reduce voltage and current harmonics contents. Moreover, depending on the adopted modulation, they can significantly reduce the part of power losses caused by commutations, lowering switching frequency down to fundamental frequency operations. Modulation techniques i.e. those algorithms imposing, step-by-step, the right state to output power devices thus controlling their evolution, represent a key element in multilevel converter design. According to literature, modulation methods can be divided among high frequency and fundamental frequency methods. Selective Harmonic Modulation techniques SHE are methods operating at fundamental frequency. Their distinctive feature is the elimination of one or more frequencies from converter outputs. According to literature, SHE are based on preliminary off-line computation based on complex methods, usually based on the use of artificial intelligence and in a subsequent real time application of computed values through look-up tables. The off-line algorithms return sets of switching angles stored in look-up tables, which are scanned during real-time operations for selection of the best set of angles. These approaches require large amounts of memory space, lead to resolution issues in commutation angles and are not very flexible in closed-loop operations. Analytical methods, instead, offer significant advances, including the exact problem formulation, easy and effective real-time implementations, selective harmonic elimination or mitigation capabilities, the possibility to cascade modulator and outer control loops. The speech, after a theoretical discussion on some analytical methods for modulation of MLC developed by authors, will present some experimental results and will discuss implementation issues.

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