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Selective Harmonic Elimination in a Wide Modulation Range Using Modified Newton–Raphson and Pattern Generation Methods for a Multilevel Inverter

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Abstract: Considering the aim of having low switching losses, especially in medium-voltage and high-power converters, the pre-programmed pulse width modulation technique is very useful because the generated harmonic content can be known in advance and optimized. Among the different low switching frequency techniques, the Selective Harmonics Elimination (SHE) modulation method is most suitable because of its direct control over the harmonic spectrum. This paper proposes a method for obtaining multiple solutions for selectively eliminating specific harmonics in a wide range of modulation indices by using modified Newton–Raphson (NR) and pattern generation techniques. The different pattern generation and synthesis approach provide more degrees of freedom and a way to operate the converter in a wide range of modulation. The modified Newton–Raphson technique is not complex and ensures fast convergence on a solution. Moreover, multiple solutions are obtained by keeping a very small increase in the modulation index. In the previous methods, solutions were not obtainable at all modulation indices. In this paper, only exact solutions to the low-order harmonics elimination for Cascaded H-bridge inverter are reported for all modulation indices. Analytical and simulation results prove the robustness and correctness of the technique proposed in this paper.

Keywords: Modified Newton–Raphson(M-NR); selective harmonics elimination; multi-level inverter; pulse width modulation; transcendental equations; modulation index

1. Introduction

The performance of a VSC mostly depends on the type of PWM strategy chosen for its operation. The PWM schemes for power converters can be broadly classified as high switching frequency PWM, such as sine PWM; space vector PWM; and low switching frequency, such as Selective Harmonics Elimination (SHE), Space Vector Modulation (SVM), and selective harmonics mitigations (SHM) schemes [1–10]. The high switching frequency PWM schemes (in kHz) are used in applications where power quality is of more importance than switching losses (mainly low power applications). Whereas low switching frequency (50–800 Hz) [11,12]. PWM schemes are employed in medium-voltage, high-power voltage source converters, where switching losses arethe main constraint, along with power quality. Among the different low switching frequency techniques, SHE is a pre-programmed modulation method thatwas proposed to eliminate two lower-order harmonics by having additional