ISA Transactions 92 (2019) 241–256

Contents lists available at ScienceDirect

ISA Transactions

journal homepage: www.elsevier.com/locate/isatrans

Practice article

Selective harmonics elimination in multilevel inverter by a derivative-free iterative method under varying voltage condition

Salman Ahmad [a], Mohammed Meraj [b], Atif Iqbal [b,*,1], Imtiaz Ashraf [a]

[a] Electrical Engineering, Aligarh Muslim University, UP, Aligarh, India
[b] Electrical Engineering, Qatar University, Doha, Qatar

HIGHLIGHTS

- SHE PWM for an asymmetrical CHB MLI under unequal DC Sources for different switching cases are given.
- The Solution of transcendental SHE equation is obtained using derivative free numerical technique.
- Simple in implementation with fast calculations as it avoids the evaluation of Jacobian matrix.
- The need for initial guess in the proximity of actual solution is not needed in the proposed technique.
- Inequality in the dc voltages is considered to eliminate the lower order harmonics in output.

ARTICLE INFO

Article history:
Received 13 May 2018
Received in revised form 21 December 2018
Accepted 15 February 2019
Available online 26 February 2019

ABSTRACT

Selective Harmonics Elimination Pulse width modulation (SHE PWM) presents an alternative modulation technique to operate medium voltage medium and high power converters as it reduces the switching losses. SHE PWM generates high-quality output waveform at the low switching frequency. Its application to multilevel converters furthers leads to improvement in output waveforms with lower switching losses, lesser dv/dt and lowers switching devices ratings. In this Paper SHE PWM for an asymmetrical cascaded H-bridge multilevel inverter under unequal DC voltage condition for fundamental and multiple switching cases are investigated. More harmonics can be eliminated by considering multiple switching's. The Solution of the Nonlinear transcendental SHE equation is obtained using an advanced derivative free numerical technique which. The method is simple in implementation with fast calculations per iteration as it avoids the evaluation of Jacobian and its matrix. Also the need for precise initial guess in the proximity of actual solution is not needed as an identity matrix of the size of designed variable serves the purpose. Different inequality in the dc voltages is taken to eliminate the lower order harmonics from the output. Only exact solutions for the switching angles which ensure the complete elimination of targeted harmonics are reported. Simulation and Hardware results are presented to confirm the validity of the proposed technique.

© 2019 ISA. Published by Elsevier Ltd. All rights reserved.

1. Introduction

Multilevel converter (MLC) is a very important component for processing power in a wide range of applications. The main applications of MLC include in rolling mills, compressors, grinding mills, conveyors, HVDC transmission system, statcom, active filters, train traction, renewable energy conversion marine propulsion etc. [1]. Many research groups are working on topologies, modulation techniques, and control algorithm strategies to improve the overall behavior of the system [2–4]. The important topologies of MLC are diode clamped, capacitor clamped and cascaded-H bridge multicell converters. Several hybrid topologies are also been suggested for improved performance such as mixed-level hybrid multilevel, asymmetric hybrid multilevel cells, soft-switched multilevel converters, active neutral point clamped (ANPC) etc. [2].

The performance of the power converter in most of the cases depends on the type of control algorithm such as pulse-width modulation (PWM) strategy adopted for the operation of switches [5]. The PWM schemes are broadly classified as high switching frequency (in kHz) and low switching frequency PWM (50 or few hundred Hz's). The main high switching frequency modulation techniques include sine pulse width modulation (SPWM) and space vector pulse width modulation (SVPWM) [4]. Whereas low switching frequency mainly includes selective harmonics elimination (SHE), selective harmonics mitigation

* Corresponding author.
E-mail addresses: salmanahmad19@gmail.com (S. Ahmad), meraj@qu.edu.qa (M. Meraj), atif.iqbal@qu.edu.qa (A. Iqbal), imtiazashraf@hotmail.com (I. Ashraf).

[1] Fellow IET.

https://doi.org/10.1016/j.isatra.2019.02.015
0019-0578/© 2019 ISA. Published by Elsevier Ltd. All rights reserved.