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DEVELOPMENT AND ANALYSIS OF THREE PHASE NINE LEVEL CASCADED H-BRIDGE MULTILEVEL INVERTER USING BIPOLAR AND UNIPOLAR SWITCHING SCHEMES

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DECLARATION

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references"

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DECLARATION

"I hereby declared that I have read through this report entitle „Development and Analysis Three Phase Nine Level Cascaded H-Bridge Multilevel Inverter Using Bipolar and Unipolar Switching Schemes‟"

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ABSTRACT

Multilevel inverter is one of the popular devices used in high power medium-voltage (MV) drives. The multilevel inverter has a particular advantage of operation at high direct current (DC). The most significant advantage of multilevel inverter can generate output voltage with very low harmonic distortion and synthesis a staircase voltage waveform by having multiple voltage level. The MLI can solve the problem of high harmonic distortion that produce by the square wave or the conventional inverter that have been used widely in the power DC to alternative current (AC) conversion. The total harmonic distortion (THD) can cause the additional losses, overheating and overloading to the system. There are various topologies of Multilevel Inverter are introduced; however, the most common multilevel inverter topologies are Neutral Point Clamped (NPC) inverter and the Cascaded H-Bridge (CHB) inverter. In this project, the cascaded multilevel inverter is selected because the cascade multilevel is easy to implement compared to other topologies. The cascaded inverter is more reliable because the cascaded H-bridge multilevel inverter (CHB-MLI) does not require any clamping diode and flying capacitor. The performance of cascaded H-bridge inverter was analyzed and discussed by using bipolar and unipolar switching schemes. The performance of the cascaded multilevel inverter was evaluated in term of the total harmonic distortion for current (THD_i) and voltage (THD_v) connected to the R, RL and RC load. The simulation of the CHB-MLI was tested with manipulating several parameters such as the various numbers of carrier wave, various values of amplitude modulation ratio and the various values of the frequency modulated ratio. The RL load produce the lowest of THD compared to another load that has been tested. The RL load produces the lowest THD_i which is 0.23% using unipolar switching scheme, with the 0.95 of amplitude modulation ratio (m_a) and 500 of frequency modulation ratio (m_f). The development of Hardware of Three Phase Nine- Level Cascade H-Bridge Multilevel Inverter (CHB-MLI) is conducted after the simulation result obtained. The hardware experiment is connected to only R and RL loads. The hardware experiment of the Three Phase Nine Level CHB-MLI is tested with manipulating several parameters such as various values of amplitude modulation ratio and the various values of the frequency modulated ratio. The lowest THD that produced in the hardware experiment is produced by the RL load with 1.09% of $THD_{i.}$ MATLAB simulink is used to model the

CHB-MLI. Some of the result met the standard of IEEE 519 and for high value of harmonic, the additional of passive filter will reduce the THD.

ABSTRAK

Penyongsang bertingkat (PBT) adalah salah satu peranti yang popular digunakan dalam kuasa tinggi voltan sederhana (VS) pemacu. Penyongsang bertingkat mempunyai kelebihan tertentu apabila beroperasi di arus terus (AT) yang tinggi. Kelebihan yang paling ketara daripada penyongsang bertingkat boleh menjana voltan keluar dengan herotan harmonik yang rendah dan sintesis voltan gelombang tangga dengan mempunyai tahap voltan bertingkat. Penyongsang bertingkat (PBT) boleh menyelesaikan masalah herotan harmonik tinggi yang dihasilkan oleh penyongsang gelombang persegi atau penyongsang biasa yang telah digunakan secara meluas dalam penukar kuasa daripada AT kepada AU Jumlah herotan harmonik (JHH) boleh menyebabkan kehilangan kuasa yang tinggi, panas yang berlebihan dan muatan yang berlebihan kepada sistem. Terdapat pelbagai topologi daripada PBT yang diperkenalkan; Walau bagaimanapun, topologi yang paling biasa bagi penyongsang bertingkat adalah diod terkapit-penyongsang dan penyongsang berganda. Dalam projek ini, penyongsang bertingkat berganda dipilih untuk menganalisis prestasi mereka kerana penyongsan bertingkat berganda adalah lebih mudah untuk dilaksanakn berbanding dengan topologi yang lain. Penyongsang berganda adalah lebih mudah kerana penyongsang jejambat-H bertingkat yang berganda (PBT-JHB) tidak memerlukan diod pengapit dan kapasitor. Prestasi PBT-JHB dianalisis dan dibincangkan dengan menggunakan bipolar dan skim pensuisan unipolar. Prestasi PBT-JHB dinilai dari segi jumlah herotan harmonik untuk arus (JHHi) dan voltan (JHHv) yang disambungkan kepada beban R, RL dan RC. Simulasi daripada PBT-JHB diuji dengan memanipulasi beberapa parameter seperti pelbagai bilangan gelombang pembawa, pelbagai nilai nisbah pemodulatan amplitud dan pelbagai nilai nisbah frekuensi termodulat. Beban RL menghasilkan JHH terendah berbanding beban yang lain yang telah diuji. Beban RL menghasilkan JHHi yang paling rendah iaitu 0.23% menggunakan skim pensuisan unipolar, dengan 0.95 nisbah pemodulatan amplitud (m_a) dan 500 nisbah frekuensi modulasi (m_f). yang. Pembangunan Perkakasan Tiga Fasa sembilan Tahap PBT-JHB jalankan selepas hasil simulasi yang diperolehi. Eksperiment perkakasan hanya disambungkan kepada beban R dan RL sahaja. Simulasi daripada PBT-JHB akan diuji dengan memanipulasi beberapa parameter seperti pelbagai nilai nisbah pemodulatan amplitud dan pelbagai nilai nisbah frekuensi termodulat. Nilai JHH yang terendah dalam eksperiment perkakasan dihasilkan oleh beban RL dengan 1.09% nilai JHH_i. MATLAB SIMULINK digunakan untuk memodelkan PBT-JHB. Sebahagian dari keputusan yang menepati piawaian bagi IEEE 519 dan untuk nilai harmonik yang tinggi, tambahan penapis pasif akan mengurangkan JHH.

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