CONTROLLING THE CURRENT IN A SMALL-SCALE DC MICROGRID REQUIRES THE USE OF A MULTI-LEVEL CONVERTER

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Abstract:

Since multilevel converters provide the combination of outstanding harmonic performance and low switching frequencies, they are a potential option in Small-Scale DC Power Network. With the addition of redundant sub modules in the cascaded converter chain, dependability may be further increased. Next-generation small-scale electric power networks, DC microgrids have extremely low line impedance and have been on the rise.

This phenomenon creates significant currents in the micro grids with even a little change in voltage, making quick transient response and accurate power flow regulation essential for a power flow controller. In order to achieve fast and precise power flow regulation in a dc micro grid, this research employs multi-level converters as the controllers. Because of the use of a multi-level converter, the output filter may be made rather compact. The current ripple requirement is met by the design of an LC filter at the multi-level converter's output, which is shown in this project. By comparing the performance of a multi-level converter with that of a traditional two-level converter, we find that the latter is unable to manage the flow of power via low-impedance lines at fast speed and with the same degree of accuracy. Step response analysis utilising MATLAB/Simulink simulation results assesses the control performance of each output current in light of transient changes in the power flow.

I.INTRODUCTION

For a wide range of uses in industry, inverters are invaluable. The voltage-driving strategy has gained popularity in recent years. Transient voltage and current ratings for semiconductors may be reduced by connecting them in series and parallel. In addition, the normal three-phase converter's restrictions are used up to the load's maximum voltage. The main switching frequency and the Pulse width modulation (PWM) switching frequency may be advantageous as well. The low disappearance and increased efficiency are shown by the decreased switching frequency. Greater focus has recently been placed on the multi-level inverter as a means of synthesising the spectrum signals of harmonics brought on by capacity. In addition, a multilayer inverter is crucial in delivering enhanced working voltage above the voltage limitations of standard semiconductors. Typically, the standard two-level inverter is used as the interface between the dc-link and the grid in low power solar systems. However, unique converter structures are required for today's wind turbines, which may generate anywhere from several hundred kilowatts to several megawatts of power. The high voltage stress may be handled in a number of ways, one of which is by connecting switching devices in series. However, a reliable mechanism for regulating the voltage distribution among the devices in both dynamic and static conditions is necessary for this approach to work well. When it comes to high power medium voltage applications, the Multilevel Converter is quickly becoming the technique of choice due to its widespread acceptance in the industry. These circuits may improve the quality of the spectrum over the traditional two-level design by synthesising the output waveform from a wider range of voltages.

Most grid-connected renewable energy systems deal with dc power on both the input and output sides, therefore a dc microgrid helps accomplish efficient power transfer by decreasing the number of power conversion steps between the ac and dc sides.

Due to the smaller size of the dc microgrid's nodes, such as the generators, batteries, and loads, line impedances are often extremely low. This means that even with a little change in voltage, a considerable current flows over the lines. A two-level converter requires a large output filter to dampen the excessive current. Two converters and a passive resistive load have been studied as part of a grid setup. To reduce dc micro-grid transmission losses, it suggests a hierarchical control scheme for balancing power flows and regulating voltages. Above researches have mostly used the two-level converter circuit architecture. In addition, enhancing dynamic performance is not currently a top priority. The high-speed reaction of a single converter is also the subject of ongoing research. It was stated that a dc-dc converter may be controlled to get a quick current response. This technique is based on the assumption that a low-voltage power supply, including a conversion from 5.5 V to 3.3 V and a switching frequency in the MHz range, may be built into a single integrated circuit (IC) or package. To improve the dc microgrid's steady-state and dynamic performances, the paper presented a predictive current control for a bidirectional two-level dc-dc converter. Moreover, the circuit architecture of a two-level bidirectional converter for the dc microgrid is the subject of research. It is common practise to use a two-level design for dc microgrid power converters, however this approach has inherent restrictions that prevent it from reaching a higher switching frequency and a quicker dynamic response.

Microgrids need a fast converter with fine power flow management to get around these restrictions. However, with a fast change in the reference of the power flow and load circumstances, a big LC filter makes it impossible for power flow to alter swiftly. By implementing a multi-level converter, we are able to manage the flow of power in a dc microgrid with greater speed and accuracy in the current investigation. Even without a filter, an m-level converter may provide an output voltage with m-steps. Therefore, as the level (m) grows, the output filter may be made smaller, indicating that anmlevel converter allows the ripple content of a dc output voltage to be reduced to 1/mth of that of the two-level converter. The potential for using multi-level converters in a dc microgrid has been investigated. There are, however, no reports of research towards the construction of a dc network with several multi-level converters. This research looks at how the level count is used as a design parameter in the power flow controller for a dc small scale grid. The research contribution of this paper is the level-based, all-encompassing design of converters and LC filters for the dc micro grid. More specifically, a dc network with many multi-level converters is built and used in tests.

II. CONCLUSION

In the course of our research, we looked at the use of multi-level converters as a means of achieving quicker current management in a dc microgrid that had interconnections with an exceptionally low impedance. When developing the technique for the output filter of the power flow controller, a number of factors were taken into consideration throughout the design process. These factors included the steady-state ripple, the gradient of the transient change in the output current, and the number of output levels. Simulations and tests were carried out in order to explore the current-control capabilities of both the two-level and the seven-level converters. According to the findings of the research, a power flow controller that makes use of a multi-level converter is capable of achieving quicker current regulation while maintaining the same degree of current ripple. Because of this, it is anticipated that the multilayer power flow controllers would have a substantial influence on the small-scale dc distribution networks, offering improved levels of stability and dependability as a result of their quicker power flow regulation.

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