Management of rapid current in small size power systems by using multi-level converter

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Abstract: DC micro-grids have been emerging as next-generation small-scale electric power networks, where the line impedance is very low. This phenomenon causes large currents in the micro-grids, even for a slight change in voltage; therefore, it is critical for a power flow controller to have faster transient response and precise power flow control. In this paper, multi-level converters are applied as the power flow controllers to realize high-speed and high-precision power flow control in a dc micro-grid. The output filter can be small, as a multi-level converter is used. This paper also presents the design of the output LC filter of a multi-level converter to satisfy a requirement of current ripple. We experimentally verified that a multi-level converter with a smaller filter can realize high-speed and high-precision power flow control for low line impedance conditions compared with the conventional two-level converters.

Index Terms – Multi-level converter, two-level converter.

I. INTRODUCTION

How should we increase the level of produced solar cells (PV)? From this point of view, we are looking at electric infrastructure in application locations at power stations to electrical devices. DC electric electricity is generated by PV panels. The power must be transformed to AC that is synchronized with industrial grids to be distributed to application sites and dispersed. To reduce energy diffusion through communication, the power is distributed near the supply site after the electrical output has also been brought up to 66 kV or higher. After mono-processed frequency decrease at stations and pole installed transmission lines, the power is converted to 100 V and provided to housing channels. Therefore, in relation to cost, effectiveness and long life for generation services, we must consider how we can develop effective electricity distribution systems for PV generation, if we use the source of electricity as an investment.

Transmitting services for generating photovoltaic sometimes remain inactive, as do generation facilities themselves, since they do not produce electricity during the night and bad weather. If input from renewable energy was much lower than transmission capacity it can be taking care of by established installations. We assume a massive photovoltaic farm compared to a nuclear power station with a Giga wattage class output to easily understand the issue. PV production, whose environment has low yield, requires vast land to produce a very large capacity. The generation services therefore have to be built in outlets which are far from consuming areas. The transmitting services must also have sufficient large ability to produce optimum current under best snow circumstances. Throughout off-generating times like at night and under impoverished sunlight they don't operate. If photovoltaic plants provided continuous enormous power as mechanical or nuclear energy plants form dam, we would choose a much-reaching power grid that links detached outlets and a producing center.

Electrical portable hard drives, such as electrodes, can withstand PV production fluctuations and realize inductive loads. This system, therefore, decreases transmitting capabilities efficiency and needs very huge extra costs for the massive inverters. So we cannot implement this approach until significantly reduced prices are available for storage systems. Then placed together steam turbines that allow us to modify the power consumption rather quickly. The integrated plant will handle the PV production variance and thus increase the transmitting service ratio. Nevertheless, it involves a parallel developed electric power plant similar to the PV, and that for our original goal is a motorway way to introduce a significant amount of PV. As described above, photovoltaic huge-scale plants in remote locations have a significant economic performance issue. We need a new energy system which allows a vast amount of decentralized PV systems to be deployed at demand sites. This article suggests DC micro optimization techniques as an alternative to perform the easy-current response in a dc–dc converter mentioned for such a function input method. This approach requires a small-voltage power source with a 5.5 V to 3.3 V change, and a MHz changing frequency to be built into a chip or box. Chen and Xu[1]-[5] proposed a computational present regulation for a two-level dc–dc unidirectional transformer to boost the dc micro grid’s constant-state and fluid efficiency. There are research concerned with such a two-level unidirectional transformer circuit neural networks for the dc micro grid. The convenient two-level hyperbolic geometry has typically been implemented for the power inverters on both the dc smart grid; however, the two-level topology has technical limitations in obtaining a greater frequency of shifting and quicker adaptive response. We are using a multi-level converter throughout the current study to achieve higher frequency and reliable energy routing in a dc micro grid. A m-level conversion can generate a voltage with output M-steps without so much as a filter. This clearly states that a m-level converter allows the trickle material to be reduced.
to 1/mth that of the two-level transformer in a dc maximum output; thus, as the rate (m) rises, the output filters may become smaller. Application of multi-level converters to dc wind generator has been examined. However there are no research that use numerous multi-level converters to build dc system.

II. DESIGN OF POWER FLOW CONTROLLER AND FILTER

The connection belongs to the power load balancing shown between two points in fig 1. A dc micro grid is composed of three module types. In this paper, the design procedure of the power flow controller for a dc small scale grid is investigated by dealing with the number of the levels as one of the design parameters. The contribution of this paper is in the comprehensive design of the converters and LC filters for the dc micro grid based on the number of the levels. Moreover, experiments are conducted by constructing a dc network with multiple multi-level converters.

1. PV
2. Battery bank
3. Unidirectional loads

(m-2) flying capacitors and switches (2m-2) are included in a m-level converter if the number is available. Levels rise then the amount of sequence connected switches also rises in relation to the number of multilevel converters we assign low power rating and the voltage resistance for each switch if the number of stages rises. The output switching frequency also raises the method of control, so the linkage between the reduce elements and the outputs will not change with the sensors.

The output filter received with the main theme to reduce both constant ripple (study condition) and variable state at a time. We can note the large change in the output ripple for multilevel and two-level by using the better filter parameter between the multilevel and two-level converters.

fig 1. Circuit for power flow control between two nodes

fig 2. Circuit configurations for power flow controller

fig 3. Circuit configurations of power flow controller of multi-level topology (seven-level case)

Compared with multi-level the output ripple is low in two levels. In this result as the number of levels in the LC filter decreased as the response time in the output also decreases simultaneously. It therefore consists of (2m-2) switches and (m-2) flying capacitors as opposed to the two level converters of multi-level flying capacitor (m-level). Nonetheless, the system shows the dynamic actions as the number of levels increases.
The figure above shows the reference between the cascade time and the dumping time in both the two-level and multi-level converters. The dumping time is more simultaneous in the two-level converter, the cascade is also more comparable to the multi-level converter. The figure shows that in construction, the two-level converter is necessary to recognize improving both the cascade (ripple) and settling time for the same switching frequency. In construction, when the rise in the current step reaction is analyzed instead of settling time. Consider that the gradient is time-settling and the current response is optimized for critical damping, and the figure 4 above shows the equivalent circuits in the steady-stage ripple evaluation and the worst output currents. Converter case operation. The maximum current shift is calculated by using the theoretical values below and the R1 and R2 resistors are ignored. The ac current is calculated in the stable state of the harmonic voltage and harmonics nth order. And the constant ripple current is determined by differentiating between the maximum and minimum values.

III. Investigation of control performance two-level and seven-level power flow controllers

The current control capability shall be considered in the two level and multi-level converters. In the dc micro grid the network shall consider comparing the three nodes and three converters and in fig 5 three battery packs shall be considered as the bidirectional power supplies and connected between the power flow controllers and the distribution lines. There are two forms of distribution network being built. Parameters showed up in Fig. 5. The two-level and seven-level force stream controller yielding channels are organized using (1)–(5) for a present 0.01 A wave. The wave must meet the requirements for a fixed channel, paying little attention to the length of the appropriation line. The channel's plan becomes stringent, as the length is shorter. The length in this structure is believed to be at least 1 m. The transporter recurrence of the seven-level converter using a six-bearer stage moved adjustment is set at 83.3 kHz, considering that a similar yield PWM recurrence is used for both converters. Channel condensers of similar value are used in this design model for the simplicity of correlation of. It can be very well asserted from that the seven-level converter channel parameter decreases by about one-sixth that of the two-level converter.

In this recreation, use the MATLAB / SIMULINK circuit test system, the control execution of each voltage current hereby be assessed in the progression reaction, taking into consideration the transient changes in the force currents. The reference output current of each converter is shown in Fig. 6. The last, one of the flows are set to zero at first, which implies that the yield voltages of all the flows Second, a current of 2.0 A is achieved from Node1 to Node2 by modifying the converters' yield voltage along these lines by fixing the current i3 at zero. Fourthly, a current of 2.0 A streams from Node1 to Node3, improving current i2 at 2.0 A along the same axes. Ultimately a Node1 current of 4.0 A is appropriated similarly (2.0 A) to Node2 and Node3. The current-control plot embraced only by every counsel-worker By human means, It is seen that the seven-level converter's settling time turns out to be approximately one-fifth that of the two-level converter, which is steady because of the seven-level converter's lower time flow. It is further discovered that the i2 and i3 reaction calculations cannot pursue the reference projections at the separate moments of the change in progression (0.00), this is attributed to the restriction of the converter's data transfer reaction strength. Their pinnacle esteems are seen as 0.25 A separately in the two-level and 0.5 An in the seven-level converter. While the settling time in the seven-level converter rises multiple times, the dissonance (swell) pinnacle value just copies. The st's capacity to higher force stream on these lines, considering a comparable bearer recurrence for both...
converters with an effectiveness angle would be a useful strategy for a reasonable test. In a certain way, the two-level converter's transfer recurrence was adjusted from 500 to 83.3 kHz, and the channel's inductance was boosted to 60 mH.

fig 6. Simulation results of power flow using three two level converters (fpwm=83.3kHz)

fig 7. Simulation results of power flow using three two level converters (fpwm=500kHz)

fig 8. Simulation of power flow using three seven level converters (fpwm=500kHz)

IV. CONCLUSION

In this paper, we investigated multi-level converters to realize faster current control in a dc micro grid with extremely low-impedance interconnections. The design procedure for the output filter of the power flow controller was deliberated considering the number of the output levels, steady-state ripple, and gradient of the transient change in the output current. The current-control performances of the two-level and seven-level converters were investigated using simulations and experiments. The study established that a power flow controller using a multi-level converter realizes faster current control, fixing the current ripple in the same level. In this way, the multi-level power flow controllers are expected to strike a significant impact on small-scale dc distribution networks providing higher stability and reliability based on their faster power flow control.

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