A Novel Three Phase Triple PSM Based Diode Clamped Multi Level Isolated DC-DC Converter System

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ABSTRACT: A triple-level circulate (TPS) stability method with reduced transformer's voltage pressure is proposed throughout this paper for the diode-braced full-join (FB) 3-stage disengaged DC/DC converter. The proposed method can maintain the transformer's best voltage changes (1V) at simply 50% of the understanding voltage (Vin/2) with the aid of using utilising 3 level circulate delays. Subsequently, contrasting and consequently the conventional strategies, the blessings of the proposed system include: 1) lessening the voltage alternate charge (dv/dt) at the transformer and 2) enhancing the transformer's voltage sounds because of the really well worth of the staggered voltage. Also, the proposed method has operating modes with 0-voltage changing (ZVS) for enjoyable the huge records voltage variety. At last, the proposed device is checked with the aid of using each duplicate and trial results.

Keywords: – Full-Bridge (FB), Zero-Voltage Switching (ZVS), Voltage Changes (1V).

INTRODUCTION

When refers to the type of microgrids, DC microgrids are becoming promising solutions for future smart-grid systems because of the increasing usage of renewable distributed energy sources and energy storage systems in DC form. In addition, DC microgrids have obvious merits such as high efficiency, frequency stability, no reactive power, and easy system control [2]–[7] in comparison with AC microgrids. In general, DC microgrids prefer a high DC bus voltage to increase the power delivery capability and reduce transmission losses. In DC microgrids, isolated DC/DC converters, which are responsible for delivering power and interlinking different bus voltages, are fundamental components and largely influence performances of DC microgrids [8]–[10]. Accordingly, the researches on the highinput-voltage and high-reliability isolated DC/DC converters are desired for DC microgrids. For high voltage applications,

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one of most competitive candidates is the three-level (TL) based isolated DC/DC converter due to the lower switch voltage stress in comparison with the two-level based DC/DC converter [11], [12]. A lot of research about the TL based isolated DC/DC converter has been carried out so far. Reference [13] proposed an improved half-bridge (HB) TL isolated DC/DC converter (TL-IDC) with the simple phase-shift control. Based on [13], a TL-IDC with an auxiliary circuit was proposed in [14] to reduce the circulating current and thus improve the efficiency. Reference [15] proposed a new TL-IDC with series-connected transformers to both realize the zero-voltage switching (ZVS) in the almost entire load range and balance the output currents. In [16], a novel four-switch TL-IDC with a compact circuit structure was proposed. Based on [15], four kinds of TL-IDCs with wider soft-switching range were proposed in [17]. In [18], a novel ZVS control strategy was proposed to balance the currents among input capacitors and primary-side power switches for the four-switch TL-IDC proposed in [16]. Additionally, a new ZVS TL-IDC with a corresponding secondary-side phase-shift-control was proposed in [19] to reduce the circulating current for high voltage applications. The above research is mainly about the HB TL-IDCs. However, the HB converter maybe not the most attractive choice for the high-power applications due to the high current stress on the power switch. Normally, the FB converter is preferable for high-power applications [20], [21]. Two hybrid full-bridge (FB) TL-IDCs were presented for the high-power applications in [22], [23]. Reference [24] proposed a chopping phase-shift (CPS) modulation strategy for the diode-clamped FB TL-IDC. Based on [24], a double phase-shift (DPS) modulation strategy was proposed to reduce the power switches' conduction loss in [25]. Additionally, reference [26] proposed a new modulation strategy to balance the currents among the primary-side power devices.

PWM CONTROLLER FEATURES

This controller offers a basic "Hi Speed" and "Low Speed" setting and has the option to use a "Progressive" increase between Low and Hi speed. Low Speed is set with a trim pot inside the controller box. Normally when installing the controller, this speed will be set depending on the minimum speed/load needed for the motor. Normally the controller keeps the motor at this Lo Speed except when Progressive is used and when Hi Speed is commanded (see below). Low Speed can vary anywhere from 0% PWM to 100%.

Progressive control is commanded by a 0-5 volt input signal. This starts to increase PWM% from the low speed setting as the 0-5 volt signal climbs. This signal can be generated from a throttle position sensor, a Mass Air Flow sensor, a Manifold Absolute Pressure sensor or any other way the user wants to create a 0-5 volt signal. This function could be set to increase fuel pump power as turbo boost starts to climb (MAP sensor). Or, if controlling a water injection pump,

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Low Speed could be set at zero PWM% and as the TPS signal climbs it could increase PWM%, effectively increasing water flow to the engine as engine load increases. This controller could even be used as a secondary injector driver (several injectors could be driven in a batch mode, hi impedance only), with Progressive control (0-100%) you could control their output for fuel or water with the 0-5 volt signal.

MODELLING OF CASE STUDY

In this paper, a triple-phase-shift (TPS) modulation strategy is proposed for the diode-clamped FB TL-IDC as an extension of our previous work [29]. High voltage changes with the value of the full input voltage on the transformer occur under the conventional strategies, but the proposed strategy can maximum value of these voltage changes at only half of the input voltage (Vin/2). Consequently, the proposed strategy can mitigate the voltage stress, voltage change rate (dv/dt), and voltage harmonics on the transformer. Additionally, the proposed strategy comprises two operating modes with ZVS to fulfill the wide input voltage range. The transition between these two operating modes is seamless. Finally, the simulation and experimental results are given to validate the proposed strategy. Comparing with the previous work in [29], this paper adds the following new contents. 1) The introduction has been enhanced. 2) The analysis of the operation principle of TPS strategy has been enhanced. 3) The theoretical analysis of the ZVS performances under the TPS strategy has been added. 4) The verified simulation results have been added. 5) More experimental results and related analysis have been added, including ZVS performances, transformer's voltage harmonics, and efficiency comparison. The rest of this paper is organized as follows. The proposed strategy's operation principle is analyzed in detail in Section II. Section III presents a detailed analysis of the characteristics and performances of the diode-clamped FB TL-IDC under the proposed strategy.

OPERATION PRINCIPLE

The circuit topology of the diode-clamped FB TL-IDC is presented in Fig. 1, in which Ci1 and Ci2 are two input capacitors; S1 − S8 and D1 − D8 are power switches and diodes; C1 − C8 are junction capacitors of S1 − S8; Cs1 and Cs2 are two flying capacitors; D9 −D12 are clamping diodes; Tr is the transformer; Lr is the leakage inductance of Tr plus the inductor in series with Tr if added; Dr1 − Dr4 are output rectifier diodes; Lo is an output filter inductor; and Co is an output filter capacitor. Additionally, V1 and V2 are voltages on Ci1 and Ci2, respectively; Vin is the input voltage; Vab and ip are the primary-side voltage and current; n is the turns ratio of Tr ; iLo is the current on Lo; Vo is the output voltage; Io is the output current. It is well known that the two-level FB isolated DC/DC converter is one of the most simple and common circuit topologies. When comparing with the two-level full-bridge isolated DC/DC converter, the diode-clamped FB TL-IDC as shown in Fig. 1 has

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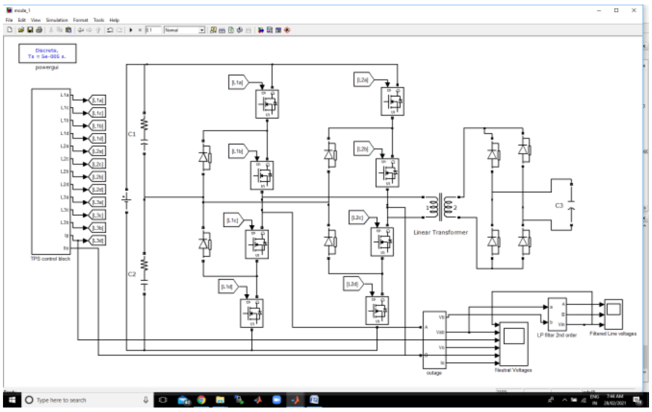
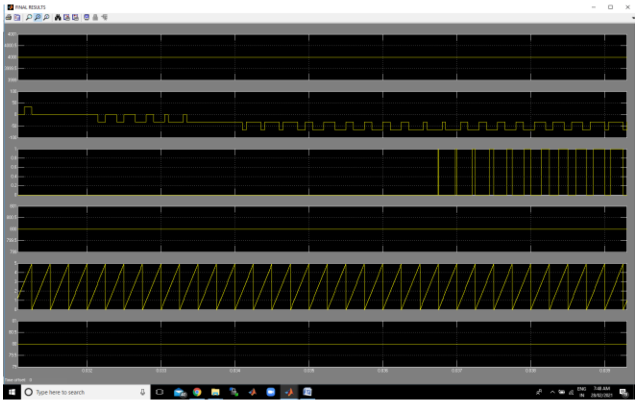
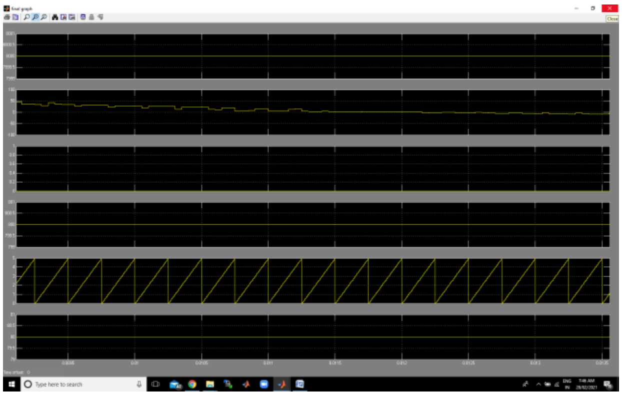
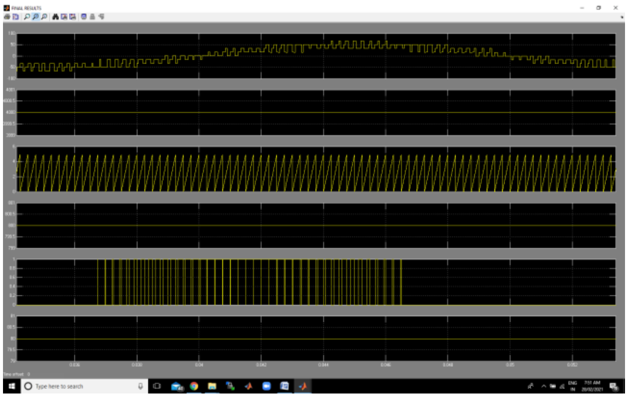
more complex topology and control strategy, which means it would have higher cost and implementation complexity. However, the diode-clamped FB TL-IDC has the following merits. 1) It can withstand higher input voltage because the voltage stresses of power devices in the three-level converter is only half of that in the two-level converter. Therefore, it is more suitable for higher voltage applications. 2) It has a reconfigurable circuit structure with two operation modes, which can thus satisfy a wider range of the input voltage. 3) It has a lower ripple current on the output inductor thanks to the benefit of multi-level voltage. The detailed explanations about these merits will be provided in the following contents. It also needs to be mentioned that the diode-clamped FB TL-IDC as shown in Fig. 1 has two flying capacitors Cs1 and Cs2, which is different from the conventional diodeclamped multi-level topology without flying capacitors.

SAMPLE RESULTS









CONCLUSION

In this paper proposes a triple-phase-shift (TPS) modulation strategy for the diode-clamped FB TL-IDC to improve the transformer's voltage stress. By employing the three phaseshift delays, the transformer's voltage changes can be kept at only half of the input voltage (Vin/2) under the proposed strategy. Consequently, the voltage stress, voltage change rate (dv/dt), and voltage

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harmonics on the transformer can be reduced when comparing with the conventional strategies. Additionally, the proposed strategy is composed of two operating modes that can not only achieve ZVS but also fulfill the wide input voltage range. The transition between these two operating modes is seamless. Finally, the simulation and experimental results validate the proposed strategy.

REFERENCES

[1] J. Duan, C. Wang, H. Xu, and W. Liu, ‘‘Distributed control of inverter-interfaced microgrids based on consensus algorithm with improved transient performance,’’ IEEE Trans. Smart Grid, vol. 10, no. 2, pp. 1303–1312, Mar. 2019.

[2] R. S. Balog, W. Weaver, and P. T. Krein, ‘‘The load as an energy asset in a distributed DC smart grid architecture,’’ IEEE Trans. Smart Grid, vol. 3, no. 1, pp. 253–260, Mar. 2012.

[3] H. Mohsenian-Rad and A. Davoudi, ‘‘Towards building an optimal demand response framework for DC distribution networks,’’ IEEE Trans. Smart Grid, vol. 5, no. 5, pp. 2626–2634, Sep. 2014.

[4] G. F. Reed, B. M. Grainger, A. R. Sparacino, and M. Zhi-Hong, ‘‘Ship to grid: Medium-voltage DC concepts in theory and practice,’’ IEEE Power Energy Mag., vol. 10, no. 6, pp. 70–79, Nov. 2012. [5] C. Liu, C. Liu, and G. Cai, ‘‘An isolated modular multilevel converter (I-M2C) topology based on high-frequency link (HFL) concep,’’ IEEE Trans. Power Electron., vol. 35, no. 2, pp. 1576–1588, Feb. 2020, doi: 10.1109/TPEL.2019.2923355. [6] B. Zhao, Q. Song, J. Li, W. Liu, G. Liu, and Y. Zhao, ‘‘High-frequencylink DC transformer based on switched capacitor for medium-voltage DC power distribution application,’’ IEEE Trans. Power Electron., vol. 31, no. 7, pp. 4766–4777, Jul. 2016.

[7] C. Wang, J. Duan, B. Fan, Q. Yang, and W. Liu, ‘‘Decentralized high-performance control of DC microgrids,’’ IEEE Trans. Smart Grid, vol. 10, no. 3, pp. 3355–3363, May 2019.

[8] Fuzzy based compensator for power quality improvement in grid connected hybrid energy system.

[9] Investigation on execution of hybrid micro grid for remote villages.

[10] Comprehensive study report on circuit breakers utilized in HVDC transmission system.

[11] Load frequency control of multi area power systems via constrained feedback control schemes.