VOLTAGE SAG MITIGATION IN PV BOOT-STRAP CONVERTER INVERTER SYSTEM

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Abstract—This effort displays an idea to straightforwardly mitigate sag in PV-Inverter system. This effort deals with designing, modeling & comparison of PV fed Bootstrap converter and three phase inverter (PVBSCTPI) system with and without LVRT (Low voltage ride through). Here, PV is utilized as a source. The Simulink-models for PVBSCTPI with and without LVRT have been developed using the-elements of Simulink & investigations are executed. The outcomes are compared in terms of output voltage, Real & Reactive power. The outcomes represent that voltage sag of PVBSCTPI system is mitigated using a DVR. The improved performance in terms of voltage has been obtained with LVRT based - PVBSCTPI system. The output voltage and power are found to be higher with LVRT.

Keywords: Bootstrap converter, PV, Three phase inverter, Three phase load, LVRT.

1. INTRODUCTION

Initially, there had been the ordinary utilization of highly advanced conversions in the business sector, examples being the light driver in high sum releases, the sun powered cell model, and the uninterruptible force [1]. When it comes to the sun-based model, especially in relation to its estimation, it is worth noting that it calls for the use of a high voltage-boosting converter, which ensures that there is a shift from low to high voltage. For the air conditioner, it aids in the conversion from direct current to alternating current. Given the high voltage-boosting converter, it constitutes a flyback converter or an ongoing boost. In its structure, it is worth noting that the boost-converter comes with a straightforward system, but it does not produce high proportions of voltage change. With the flyback converter, it is worth indicating that it comes with high voltage transformation proportions, yielding a huge relating spillage inductance. In the literature, therefore, several high voltage-boosting converters have been proposed and implemented [2]. The methods through which the proportion of voltage transformation could be improved have also been proposed and they are determined by the manner in which the quantity of inductors is
introduced. For the inductors, it also notable that they are linked to the arrangement that is adopted in the course of time frame demagnetization, implying that they siphon or utilize the energy resulting from the info voltage and also the energy that the inductors produce. The target system in this case entails the yield terminal, which allows for the acquisition or realization of a higher proportion of voltage change.

High voltage transformation proportions were accomplished by coupling inductors, yet the voltage spikes-because-of-the going with spillage inductances and the intricacy in the relating circuit investigation were unavoidable. In [3], gliding yields, along with confounded circuits, frustrate examinations and applications. Despite the fact that the converters were proposed with basic activity standards, their voltage transformation proportions were excessively low. The voltage-boost-method was utilized to help the yield voltage, yet the voltage transformation proportions were not sufficiently high. In [4], despite the fact that the voltage transformation proportions can be updated by expanding the quantity of voltage-boosting cells, extra parts or coating dynamic switches are required. This would make the general circuits muddled and would require the comparing confined drivers. For the reasons expressed over, two high voltage-boosting circuits, in light of 2bootstrap capacitors &2inductors, were introduced here. Most importantly, albeit two inductors were associated in arrangement during the demagnetizing time frame, varieties in estimations of these inductors permit such converters to work suitably.

Furthermore, in light of various switch turn-on types and distinctive diode associations, 2voltage-boosting converters with various voltage transformation proportions were created under comparable circuit structure. Under a similar condition that 2inductors &2capacitors were utilized aside from the information capacitor, any of the proposed voltage change proportions was higher than the various voltage transformation proportions in the KYboost-converter [5]. Then again, under the condition where similar segments were utilized, the proposed converters had higher voltage transformation proportions. Likewise, for every converter, just a single HB driver &solitary-low side entryway driver were required, yet no detached gate driver would be required. In this, a short outline of the activity of these 2converters was given alongside some exploratory outcomes gave to show the viability of such converters.

For the *LVRT (low-voltage*ride-through) capacity, it is a crucial factor that affects the functionality of network codes. For such a prerequisite, it is notable that it comes in different forms, determined by the nature of the framework or model with which it interacts, as well as the security system that is utilized. Under the LVRT prerequisite, it is notable that the breeze-turbines are associated with the lattice in situations entailing voltage plunges & voltage interference in relation to the residual voltage, especially in environments marked by 15% of ostensible voltage magnitudes.

Advances that can improve LVRT ability of acceptance generators by controllable receptive current infusion, for example, static compensator (STATCOM), had been accounted for in the writing as in [6 and 7]. In any case, the principle downside of utilizing STATCOM was the high energy needed to infuse a specific current through a coupling reactance so as to upgrade the voltage level of the PCC. On the other hand, DVR* had been utilized as one of the answers for improve LVRT ability of SCIG and DFIG as in [8]. DVR can be utilized to infuse little segment of arrangement voltage so as to satisfy LVRT necessity in a similar way that STATCOM does. Notwithstanding, the energy required was practically littler than that required by a shunt associated STATCOM. Then again, the primary burden of DVR was the multifaceted nature of regulators needed to remunerate the flawed voltage waveforms. By and by, exhaustive reenactment examination of moderating voltage plunges and swells utilizing STATCOM and DVR had been widely introduced in the writing as in [9].

From the previously mentioned writing overview, it very well may be inferred that adequate work had tended to the utilization of STATCOM and DVR for upgrading the LVRT of breeze-generators. Nonetheless, as indicated by the best of the creators 'information, everything research done here had just thought to be single WTs or a likenes the breeze ranch [10]. The nearby and focal executions of STATCOM and additionally DVR inside breeze-ranches had not been tended
to yet. Subsequently, the commitment of this work was to research the neighborhood/focal remuneration of the 2advancements inside the whole wind ranch. The work proposed in this way plans to give suggestions and specialized rules with respect to the one of the principle viable answers for increment CCT and consequently improve the transient soundness of IG's was the utilization of controlled responsive force gadgets, in particular adaptable substituting current transmission framework (FACTS).STATCOMs and static VAR compensators (SVCs) were instances of shunt associated FACTS gadgets, while DVRs were instances of arrangement receptive force compensators. The utilization of these gadgets had been energized by the advancement in power electronic switches. Then again, DVRs with various controlling procedures had been utilized in writing for voltage lists/swells alleviations a practical arrangement [11]. In this, DVR was displayed in PSCAD utilizing a controlled sinusoidalPWM-inverter. The controlled inverters were needed to infuse certain voltage, ordinarily in the scope of 0.1 p.u, during deficiency conditions. The control circuit is appeared in Figu3, where the genuine voltage delivered by the inverter is contrasted with a specific reference an incentive so as to create a blunder signal.

Refer[12] contended that controlling the edge(δ) of thereference adjusting sign will influence the rms yield voltage. In any case, this was not basically conceivable on the grounds that controlling the edge (δ) will influence predominantly the yield intensity of the controlled inverter. In view of the conversation, for diagnostic analysis,SCIG with DVR can likewise be spoken to by the proportional circuit appeared in Figure 4, where the DVR was demonstrated as a voltage Wellspring of size (ΔV).

The above writing doesn't manage the mitigation-sag in PV-inverter framework utilizing DVR. This work proposes DVR for power-quality improvement of PVBSCTPI framework.

2. SYSTEM DESCRIPTION

Block diagram of PV fed bootstrap converter and three phase inverter without LVRT is appeared in Fig 1. The yield of PV is boosted using boost-strap-converter (BSC). The yield of BSC is inverted using TPI.

![Block diagram of PV fed bootstrap converter and three phase inverter without LVRT](image)

**Fig. 1:** Block diagram of PV fed bootstrap converter and three phase inverter without LVRT

Block diagram of with LVRT is appeared in Fig 2. A DVR injects voltage in the line to compensate the voltage drop. Simulation parameters of PVBSCTPI are given in able-1.
Fig. 2: Block diagram of PVBSCTPI with LVRT

Table.1: Simulation parameters

| Parameter      | Value  |
|----------------|--------|
| $C_1$          | 50µF   |
| $L_1$          | 0.5mH  |
| $L_2$          | 2 µH   |
| $C_2, C_3$     | 0.1µF  |
| $L_3, L_4, L_5$| 100mH  |
| $C_4, C_5, C_6$| 20µF   |
| Frequency      | 50Hz   |
| Mosfet         | IRF840 |
| Diode          | IN4007 |
| $R_o$          | 110Ω   |
| $L_o$          | 150 mH |
| $V_0$          | 160V   |

3. SIMULATION RESULTS
Circuit diagram of PVBSCTPI with change in load is shown in Figure 3. Load-2 is an additional load connected in parallel with the existing load. A voltage sag occurs due to the addition of load.
Fig. 3: Circuit diagram of PVBSCTPI with change in load

Voltage across PV is appeared in Figure 4 and its value is 48 Volts. The circuit diagram of bootstrap converter is appeared in figure 5. Voltage across bootstrap converter is shown in Figure 6 and its value is 80 Volts. At t = 1.5 sec, load is added and hence the voltage across BSC decreases.

Fig. 4: Voltage across PV with source

Fig. 5: Circuit diagram of Boost strap converter
Voltage across RL – Load of PVBSCTPI without LVRT is delineated in Figure 7 and its value is 80 Volts. Current through RL - Load of PVBSCTPI without LVRT is appeared in Figure 8 and its value is 0.7 A.

Fig. 6: Voltage across boost strap converter without LVRT

Fig. 7: Voltage across RL – Load of PVBSCTPI without LVRT

Fig. 8: Current through RL - Load of PVBSCTPI without LVRT

Real power of PVBSCTPI without LVRT is shown in Figure 9 and its value is 78W. Reactive power of PVBSCTPI without LVRT is shown in Figure 10 and its value is 45VAR.
Circuit diagram of PVBSCTPI with LVRT is shown in Figure 11. Three phase VSI-based DVR injects a voltage using series-transformer. Additional load is connected at $t = 1.5$ sec. A voltage is injected by DVR at $t = 2.2$ sec.

![Circuit diagram of PVBSCTPI with LVRT](image)

**Fig. 11:** Circuit diagram of PV fed bootstrap converter and three phase inverter (PVBSCTPI) with LVRT

Voltage across PV is appeared in Figure 12 and its value is 48 Volts. Voltage across bootstrap converter is shown in Figure 13 and its value is 160 Volts.

![Voltages across PV](image)

**Fig. 12:** Voltages across PV

![Voltage across boost strap converter with LVRT](image)

**Fig. 13:** Voltage across boost strap converter with LVRT
Output voltage across RL – Load of PVBSCTPI with LVRT is delineated in Figure 14 and its value is 160 Volts. Current through RL - Load of PVBSCTPI with LVRT is appeared in Figure 15 and its value is 0.9A.

![Figure 14: Voltage across RL – Load of PVBSCTPI with LVRT](image)

![Figure 15: Current through RL - Load of PVBSCTPI with LVRT](image)

Real power of PVBSCTPI with LVRT is shown in Figure 16 and its value is 150W. Reactive power of PVBSCTPI with LVRT is shown in Figure 17 and its value is 75VAR.

![Figure 16: Real power of PVBSCTPI with LVRT](image)
Comparison of output voltage, real power reactive power using LVRT and without LVRT is given in table-2. By using PVBSCTPI with LVRT, Output voltage is enhanced from 80V to 160V; Real power is enhanced from 78W to 150W; Reactive power is enhanced from 45VAR to 75VAR. Fig.18 outlines the Bar chart Comparison of output voltage, real power reactive power using LVRT and without LVRT.

Table 2: Comparison of output voltage, real power and reactive power with and without LVRT

| case            | Vo(V) | P(W) | Q(VAR) |
|-----------------|-------|------|--------|
| Without LVRT    | 80    | 78   | 45     |
| With LVRT       | 160   | 150  | 75     |

Fig.18. Bar chart Comparison of output voltage, real power reactive power with and without LVRT

4. CONCLUSION
PVBSCTPI systems with and without LVRT are simulated using Matlab simulink. By using PVBSCTPI with LVRT, Output voltage is enhanced from 80V to 160V; Real power is enhanced from 78W to 150W; Reactive power is enhanced from 45VAR to 75VAR. Hence, the outcome represent that PV fed bootstrap converter and three phase inverter(PVBSCTPI) with LVRT is superior to PV fed bootstrap converter and three phase inverter(PVBSCTPI) without LVRT.

The present work deals with comparison of PVBSCTPI with LVRT and without LVRT. PV fed bootstrap converter and three phase inverter(PVBSCTPI) with LVRT in closed loop can be done in Future.
5. REFERENCES

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