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Performance Analysis of Photovoltaic-Multilevel Inverters under Transient and Voltage Stability

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ABSTRACT

This research work proposes the design and implementation of multilevel inverter (MLI)-based solar photovoltaic (PV) systems for enhanced transient and voltage stability. MLIs have become popular in PV systems due to their ability to produce high-quality output voltage with lower harmonic distortion. However, the control of these inverters can be challenging, especially during transient events and voltage variations. It discusses the design of the MLI-based PV system, including the selection of MLI topology, control strategy, and PV array configuration. The study proposes a proportional Integral strategy for controlling the MLI-based PV system, which provides enhanced transient and voltage stability. Simulation results are presented to demonstrate the suggested system's effectiveness in terms of transient and voltage stability. Comparing the proposed MLI-based PV system to traditional PV systems, the results demonstrate that it offers greater transient and voltage stability. Overall, the study highlights the potential of MLI-based PV systems with PI control strategies for enhanced transient and voltage stability. The results could have significant implications for the design and implementation of PV systems, leading to more efficient and reliable renewable energy systems.

Keywords: Solar PV, Grid, Multilevel Inverter, PI Controller, Fault Ride Through.

I. INTRODUCTION

The use of environmentally friendly power (RE) sources has fundamentally expanded in power systems throughout the course of recent years. Power converters, like inverters, are frequently used to associate these sources to the electrical network. Transient steadiness is one of the new specialized difficulties that the development of photovoltaic (PV) has achieved [1]. As a result, managing power systems during extreme disruptions has become a crucial concern.

The introduction of the new system configuration has resulted in a decrease in the system's overall inertia and governor response, which could have an adverse effect on the SMs rotor angle's transient response. The PV inverters might be able to help keep the system stable in the event of a disruption, like a short circuit brought on by a lightning strike on a transmission line. A fault detector (FD) signal may be activated in response to such an event, and the circuit breakers for the faulty line will be opened [2]. The PV inverters used in PV generation, however, offer new possibilities, such as ancillary services for SMs. Due to short circuit fault, lightning stroke appears in transmission line. The PV inverters might be able to assist in maintaining the stability of the system. Even in the present, it remains challenging to comprehend and predict future renewable energy (RE) generation scenarios. Because of this, the GCs have required that RE sources be quickly terminated when a disruption is discovered over the past ten years [3]. As long as RE penetration is little and this necessity is to prevent any synchronization loss, it is justifiable. Due to sudden change in SM synchronization there is a chance for failure of stability in the grid. The PV System is connected in medium transmission system because of this effect the inverters which are connected to the solar may be affected. So, we need to protect photovoltaic inverters from system faults and disoperation SM's. Due to Fault also, the inverters may be not operated accurately [5-10].

As per different literatures the PV inverters effected by LVRT, prefault, postfault and transient effect. So, the PV Inverters protection is more precious. By using LVRT capability, Fault Current limiters and different controllers like PI, SMC and MPC by using these topologies, the PV inverters are protected effectively. The proposed strategy performs better than the methods put forth in [17] through [19] in ensuring transient stability during the initial cycles following the FD. Section-1 describes introduction and literature review section-II depicts the system description, section-III Controlling topology section-IV explains proposed topology and section-V examines the simulation and results.

II. DESCRIPTION OF THE SYSTEM

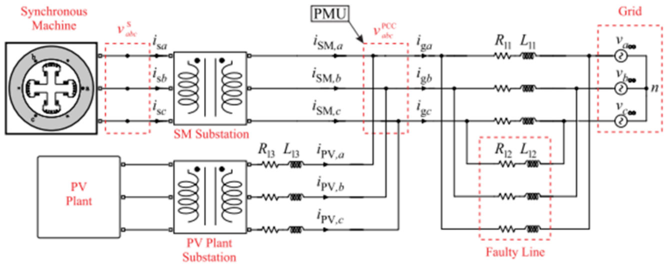


Figure 1: Schematic Diagram of Proposed Method

The power system illustrated in Figure 1 is utilized for the analysis of transient stability presented in this study. A photovoltaic (PV) system and a synchronous machine (SM) are both used in this hybrid system, and two transmission lines are used to connect both power plants to the grid.

A. Grid Connected Solar PV System:

In grid connected PV systems, the solar energy is generated by using solar irradiation and temperature. The generated power is in DC nature by using PV-Inverters Dc power is converted into AC then it is fed to the AC Grid system.

B. Synchronous Machine:

A synchronous machine is a type of electric machine that operates at a fixed speed, typically known as the synchronous speed, which depends on the machine's number of poles and the power supply's frequency. In power generation and transmission systems, synchronous machines are frequently utilised. SMs can be employed as motors or generators by converting mechanical power to electrical power. Figure-2 depicts the specified units incorporated in PV system. These units are controlled utilising a maximum power point tracking (MPPT) method while they are operating normally.

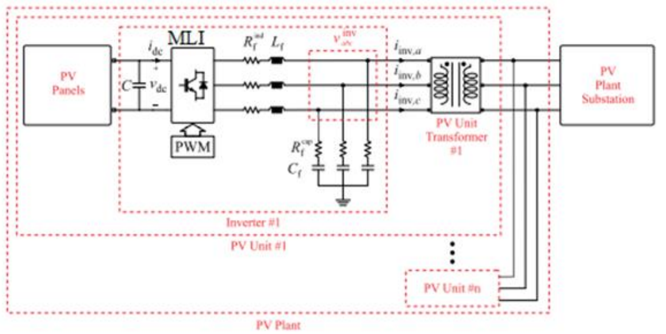


Figure 2: MLI based PV unit Schematic representation

Nevertheless, in the event of a transmission line fault, the PV inverters can switch to FRT mode with MC control and execute the suggested control measure to reduce the synchronous machine (SM) load angle (δr). It is widely recognized that an active power filter (APF) can indirectly regulate grid currents by introducing harmonic and reactive load current components. Similarly, PV-Inverters have the ability to control the currents injected into the grid, which allows them to control the current components of synchronous machines (SMs), which control torque (i.e., active power) and magnetic flux (i.e., reactive power).The SM governor typically operates after the issue has been resolved, whereas PV inverters can continue to operate during a fault period. It's crucial to keep the active power output of the SM as close to its pre-fault level as feasible in order to lessen the disruption brought on by a problem. The PV units' dc link capacitors must receive any extra active power that the malfunctioning grid is unable to absorb. The operational restrictions of the inverter must be considered because this strategy is subject to them. During a fault, the primary goal of the proposed control method is to maintain the SM active power (P_{SM}^{f}) at its pre-fault level (P_{SM}^{pre-f}). The PV plant's reference active power must be changed in order to accomplish this goal.

$$P_{\mathrm{PV}}^{*} = \bar{P}_{\mathrm{g}}^{\mathrm{f}} - P_{\mathrm{SM}}^{\mathrm{pre\text{-}f}}, \qquad (1)$$

$\bar{P}_g^F$ is the average active power being injected into the grid at the time the fault occurred. Real-time measurements of the SM and grid are required for the PV plant to function, according to Equation (1). As depicted in Figure 1, a phasor measurement unit (PMU) is set up at the SM substation to acquire these measurements. According to Equation (1), the PV plant can only operate with real-time SM and grid measurements. The PMU takes voltage and current phasor measurements at the point of common coupling (PCC). An advanced PMU can send synchrophasor data to a phasor data concentrator (PDC) at the PV plant substation, where it can be analyzed. 120 samples can be delivered per second by the PMU technology currently in use [20], [21]. Phasor data concentrators (PDCs) are used to gather and synchronize the phasor data from one or more PMUs and from other PDCs. In order for the synchrophasor software programme to get the time-synchronized data for control decision-making, the PDC plays a critical role in bridging the PMUs and the software application [21].

The communication delay, which takes sampling, data filtering, processing, input/output of the communication system, and communication distance into account, is a crucial factor in data transfer. The PV inverters may not be able to respond effectively since the PDC might not get any updates regarding during this time, the SM active power output measurement. Therefore, the capability of the proposed control scheme to guarantee transient stability must be protected from delays that are greater than a threshold, which is established as the most delay that may be tolerated. The PMU delay should not be, more than 20% of the total fault time. The simulation in Section IV has a maximum delay of 28 ms, which is within the range of 20 to 50 ms suggested by [20] for a typical system.

III.CONTROLLING TOPOLOGY

Figure 3 illustrates the suggested FRT strategy for the PV inverters. After the PMU data are transferred to the computation of power references for each PV unit (Fig. 2) can be finished using the PDC of the PV plant substation. The pre-fault SM active power must be calculated during the fault in accordance with (1).

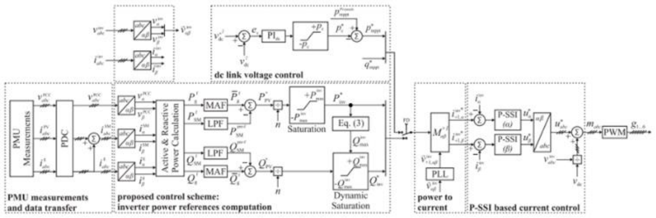


Figure 3: Proposed Controlling Topology

A very slow LPF with a time constant a few seconds longer than the typical fault period can be used to calculate the pre-fault SM active power; however, it is crucial to take into account how much less active power the grid will use. During the fault, negative-sequence and harmonic voltage and current components generate power oscillations, which are reduced by using a MAF. The calculation of reference PV reactive power follows the same rules. A PV plant's reference power cannot be calculated using oscillatory power, according to (1). Therefore, during significant grid disturbances, MAFs and LPFs are used. The MAFs have a higher cutoff frequency to make it possible for the suggested control scheme to monitor changes in the average power transferred through the grid in real time. Utilizing the pre-fault active power output of the SM, which is kept by LPFs with lower cutoff frequencies, is the suggested control strategy. The power references for individual PV units are calculated by multiplying the reference values obtained through (1) by the total number of PV units in the PV plant (n), P_{inv}^{*},, must be kept within the range of the maximum amount of active power, P_{inv}^{max}, that can be absorbed in order to ensure safety during the disturbance.

$$P_{\max}^{\text{inv}} = \frac{C}{2\Delta t}\left({v_{\text{dc}}^{\max}}^2 - v_{\text{dc}}^2\right), \quad (2)$$

An upper limit on the reference P_{inv}^{*} value prevents the DC link voltage from rising above the maximum inverter DC input voltage during an interruption. This limit is established based on the steady-state dc link voltage vdc, the maximum dc voltage V_{dc}^{max} during a disturbance, the dc link capacitance C, the maximum fault duration 1t, and the dc link voltage. Instead of the surge voltage of twice the nominal voltage of the capacitor as stated in [23], which is a less lenient limit, it ensures that the DC link voltage does not exceed the maximum inverter DC input voltage.

The maximum reactive power can be calculated as Q_{inv}^{max},

$$Q_{\max}^{\text{inv}} = \sqrt{\left(S_{\max}^{\text{inv}}\right)^2 - \left(P_{\text{inv}}^{*}\right)^2}. \quad (3)$$

It should be noted that in the suggested control scheme, the calculation of active power reference for PV units is given priority. As mentioned in [5]-[7], that explains the grid codes during the fault occurred condition, the reactive power will support which is depicted in equ-2. The FRT method utilizes the guidelines provided in [9] to calculate the current references for the inverter. These references are used to facilitate two modes of operation: oscillatory power injection at 2 times the fundamental frequency, requiring the generation of only the odd harmonic current components, or constant power injection, requiring the generation of only the fundamental-frequency positive sequence (FFPS) currents. Oscillatory power injection, when used in the suggested control scheme, has no effect on the average SM active power output because its mean value is zero; consequently, it has no effect on the variation of r. It is important to remember that, in contrast to injecting only FFPS currents, the injection of all odd harmonic currents can cause the inverter's maximum short-circuit withstand capacity to be exceeded.

$$\begin{bmatrix} {i_{+1,\alpha}^{\text{inv}}}^{*} \\ {i_{+1,\beta}^{\text{inv}}}^{*} \end{bmatrix} = M_{\alpha\beta}^{+1} \begin{bmatrix} P_{\text{inv}}^{*} \\ Q_{\text{inv}}^{*} \end{bmatrix}, \quad (4)$$

where

$M_{\alpha\beta}^{+1}$ is given by

$$M_{\alpha\beta}^{+1} = \frac{1}{\left|\vec{v}_{+1,\alpha\beta}^{\text{inv}}\right|^2} \begin{bmatrix} v_{+1,\alpha}^{\text{inv}} & v_{+1,\beta}^{\text{inv}} \\ v_{+1,\beta}^{\text{inv}} & -v_{+1,\alpha}^{\text{inv}} \end{bmatrix}. \quad (5)$$

Utilising a PLL, equation (5) determines the FFPS component of the voltage at the terminals of the PV unit, Ev_inv+1. A GDSC-PLL is employed to obtain the frequency parameter.

The suggested control strategy's maximum three-phase current ((i_{inv}^{abc}) cannot be greater than the inverter unit's datasheet-specified short-circuit withstand capacity [22].

A. VOLTAGE AND CURRENT CONTROLLERS:

Fig-3.depicts the controlling of voltage and current. As proposed in [26], under normal operating conditions, whenever the power is supplied from PV to Grid, there the regulation of DC link voltage can be evaluated. Vdc controller is used to evaluate the active power (P_C^*), so that the power flow can be controllable.

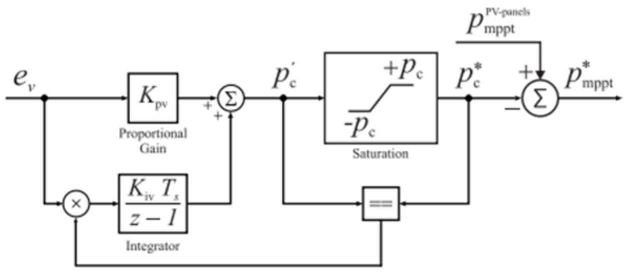


FIGURE 4. Diagram of the dc link voltage controller with anti-windup action.

In order to attain maximum power from solar PV, mppt technique is employed which evaluates the reference active power that is depicted in fig.4. The anti-windup saturation block restricts how much power variation the controller can account for, and if p0c and p*c are different values, the integral controller's input is set to zero. The MC mode of power transfer from the PV panels to the grid is turned off by activating the DC link voltage control block in response to the fault detection (FD) signal. As depicted in figure-3, the P-SSI current controlling topology is explicated. As proposed in [27] and [28], the sinusoidal signal generators with α and β for the two controllers is employed. The transmission capacity of the regulators is likewise set utilizing a relative activity. The reason for this is that the internal model principle dictates that there will be no steady-state error for sinusoidal reference signals. This is because the transfer function of the P-SSI scheme is akin to that of a sinusoidal signal. To infer the balance signals mabc, the regulators' result is multiplied by a feedforward worth of v. A PWM is then used to make an interpretation of these signs into orders (g1, g6, and so on) for the inverters' IGBTs. It is essential that the dc voltage control is performed much more quickly than the current control.

IV. PROPOSED MULTILEVEL INVERTER TOPOLOGY

Multilevel inverters are increasingly being used in grid-connected solar PV systems. These inverters are capable of generating a high-quality output voltage waveform with fewer harmonics, which can result in improved system performance and reliability. Multilevel inverters use a series of power electronic switches to generate a stepped voltage waveform that approximates a sine wave. This stepped waveform is achieved by switching the switches on and off in a predetermined pattern, resulting in a voltage waveform that has multiple levels. These inverters can reduce the level of harmonic distortion in the output waveform, which can improve system efficiency and reduce the risk of equipment failure. In this proposed in order to convert DC power into AC power, MLI Topology is employed to make the system to work more effectively that is depicted in figure-2.

V. SIMULATION BASED RESULTS

In this project, simulation-based results are presented to show how well the suggested control scheme works. VSI and MLI with FRT (Fault Ride-Through) were compared, and in Figs. 6 and 7, their transient responses were simulated.

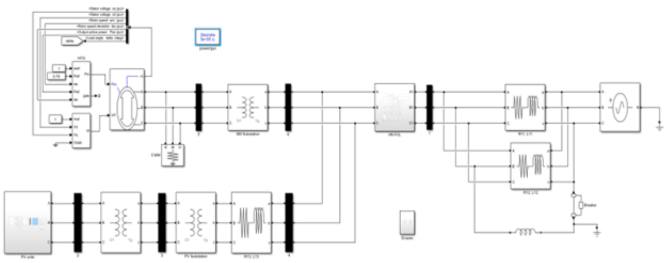
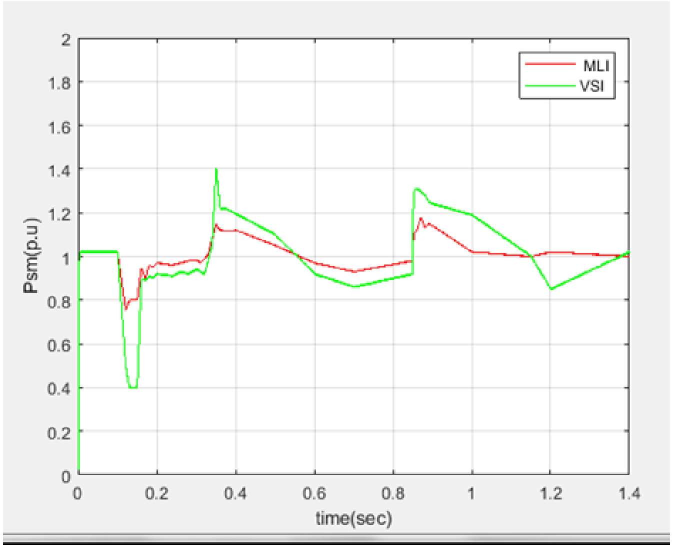
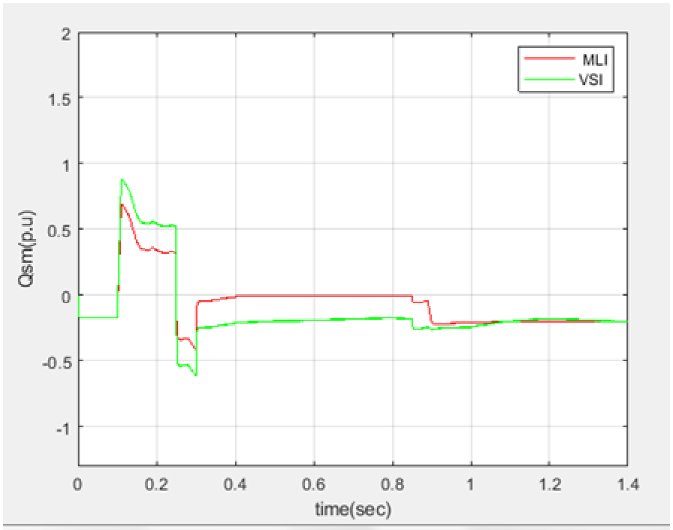


Figure 5: Simulink Model of proposed MLI based Topology

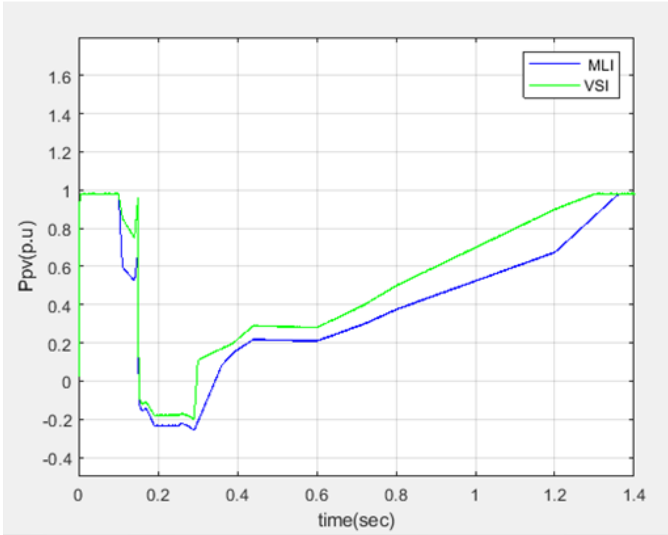
The above figure depicts the Simulink model of MLI based system topology. A current is employed in order to regulate the current component.



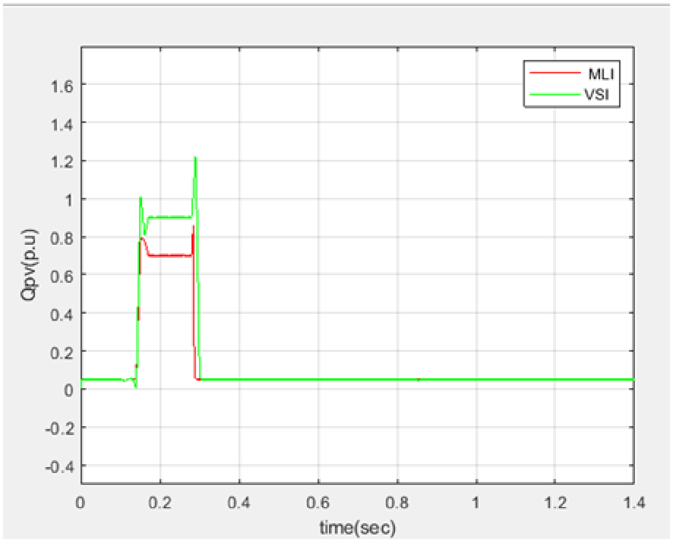
a) SM Active Power Output



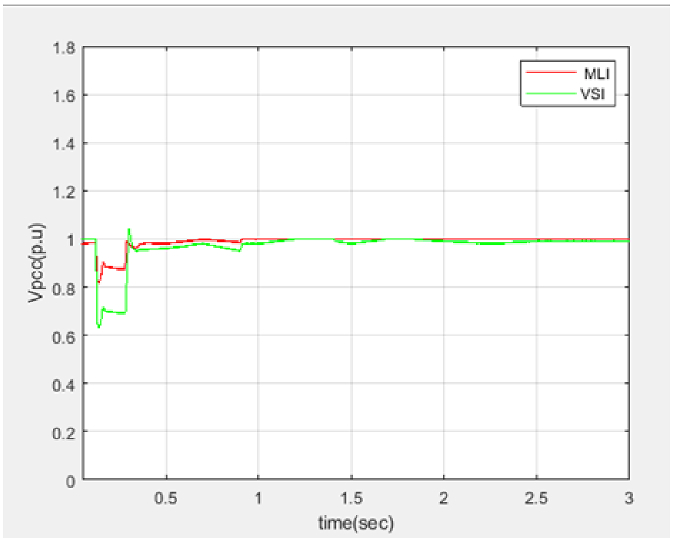
b) SM Reactive Power Output



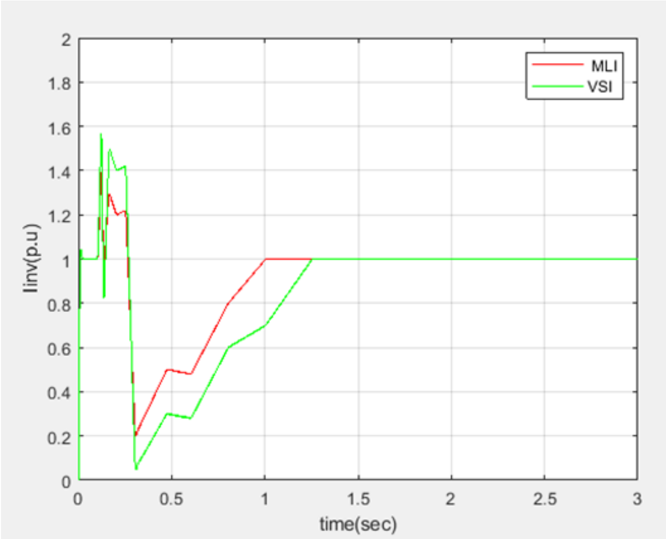
c) PV System Active Power Output



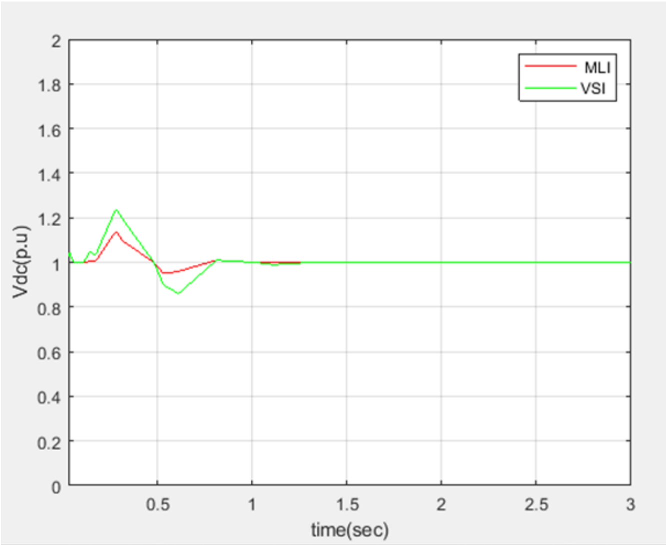
d) PV System Reactive Power Output



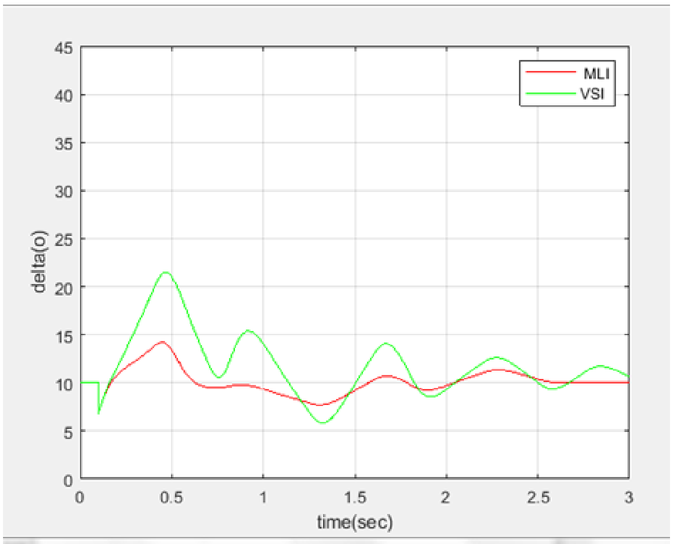
e) Voltage at Point of Common Coupling



f) PV unit's Inverter Current



g) DC Link Voltage

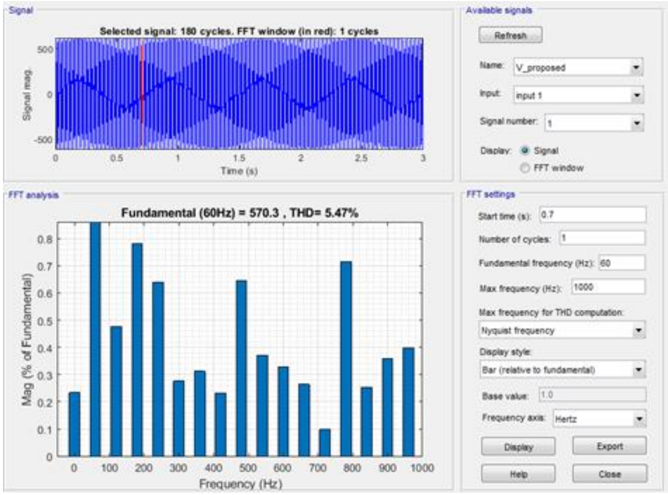


h) SM Rotor Angle

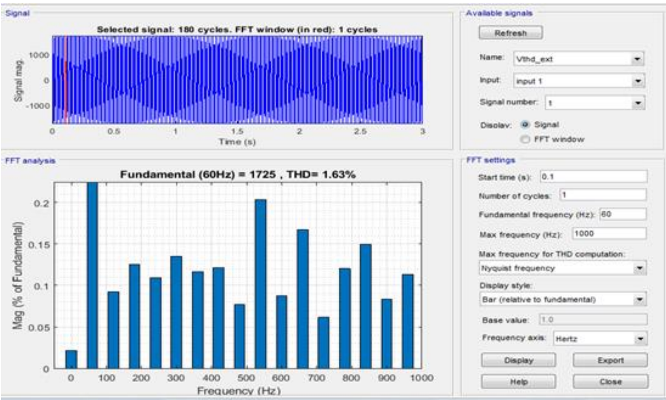
Figure 6: Comparative results of conventional VS and Proposed MLI topologies based systems

The above figure-6 depicts the simulation results obtained by using VSI and MLI in the proposed FRT based system configuration. Figure 6a illustrates the active power output of the SM with VSI and MLI. Compared to VSI, the utilization of MLI leads to a more accurate power output with fewer ripples. The proposed control approach with VSI and MLI, presented in Figure 6b, has decreased the reactive power output of the SM during faults and has reduced harmonic distortions in the MLI system. Figure 6c displays the active power output of the PV system when VSI and MLI are employed. The 16 MW limit was not exceeded in spite of the proposed control strategy starting to absorb active power during the fault. When VSI and MLI are compared, the MLI has a better ripples reduction. Figure 6d displays the PV's reactive power output. 0.98 p.u of power is injected at the time of fault occurrence. Whereas the MLI has evaluated the accurate power output. Figure-6e explains the voltage obtained at the PCC. Where MLI based system has obtained 1V compared to VSI because VSI has high harmonic distortions. Figure-6f explains the PV units Inverter Current. The MLI based system has high steady state attaining ability with less harmonic distortions when compared to VSI systems. Figure-6g depicts the voltage obtained at DC Link. The proposed control scheme absorbed active power into the dc capacitors, resulting in an increase of up to 1340 V (1.22 p.u.) but did not exceed the limit of 1500 V. This accurate voltage unit can be obtained with less harmonic distortions by using MLI when compared to VSI. In Figure 6h, the performance of SM rotor angle is illustrated using the proposed control schemes based on VSI and MLI. The findings indicate that the 48% of angle at rotor side is decreased. However, it is important to note that the proposed control scheme resulted in larger post-fault rotor angle oscillations because of the inverters' active power recovery. Moreover, the MLI based system exhibited better performance evaluation compared to the traditional VSI system.

A. Comparison of THDS:



a) VSI based voltage THD with proposed scheme



b) MLI based voltage THD with proposed scheme

Figure-7: Comparison of THDs evaluated in VSI and MLI based system

The above figure-7 a and b depicts the THDs obtained by employing VSI and MLI. In this, the % of THD obtained in grid Voltage by using VSI is 5.47%, whereas it is reduced to 1.63% after replacing VSI with MLI. So, it can be concluded that the better THD reduction can be obtained by using MLI. So, the system can have good power quality and work effectively and efficiently in an FRT scheme.

VI. CONCLUSION

In conclusion, the design and implementation of multilevel and VSI-based solar PV systems have shown promising results for enhancing transient and voltage stability. Through extensive simulation studies, it has been demonstrated that multilevel inverters offer several advantages over conventional two-level inverters, such as improved voltage quality, reduced THD, and increased efficiency. The use of a virtual synchronous generator control scheme in VSI-based systems has also been found to enhance transient stability and improve power quality by providing reactive power support during faults. The results of the simulation studies have shown that the proposed control schemes for both multilevel and VSI-based systems have significantly improved the system's response during transient and fault conditions. The proposed control schemes have been found to provide fast and effective voltage support, reduce power imbalances, and enhance overall system stability. In addition, the systems have demonstrated a high degree of reliability and robustness, even under varying solar irradiance conditions. Overall, the design and implementation of multilevel and VSI-based solar PV systems have great potential to contribute to the development of efficient and stable renewable energy systems. The results of this project provide a valuable contribution to the field of renewable energy systems, and further research in this area could lead to the widespread implementation of multilevel and VSI-based solar PV systems in the future.

VII. REFERENCES

[1]. M. Milligan, B. Frew, B. Kirby, M. Schuerger, K. Clark, D. Lew, P. Denholm, B. Zavadil, M. O'Malley, and B. Tsuchida, "Alternatives no more: Wind and solar power are mainstays of a clean, reliable, affordable grid," IEEE Power Energy Mag., vol. 13, no. 6, pp. 78–87, Nov. 2015.

[2]. N. W. Miller, "Keeping it together: Transient stability in a world of wind and solar generation," IEEE Power Energy Mag., vol. 13, no. 6, pp. 31–39, Nov. 2015.

[3]. IEEE Standard for Interconnecting Distributed Resources With Electric Power Systems, IEEE Standard 1547-2003, Jul. 2003.

[4]. W. Weisheng, C. Yongning, W. Zhen, L. Yan, W. Ruiming, N. Miller, and S. Baozhuang, "On the road to wind power: China's experience at managing disturbances with high penetrations of wind generation," IEEE Power Energy Mag., vol. 14, no. 6, pp. 24–34, Nov. 2016.

[5]. IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources With Associated Electric Power Systems Interfaces, IEEE Standard 1547-2018, Apr. 2018.

[6]. Technical Requirements for the Connection and Operation of Costumer Installations to the High-Voltage Network (TCC High-Voltage), Standard VDE-AR-N 4120, Jan. 2015.

[7]. Technical Requirements for Connecting Photovoltaic Power Station to Power System, Standard Chinese Grid Code GB/T 19964-2012, Jun. 2013.

[8]. National Grid, Guidance Notes—Power Park Modules, National Grid, National Grid House, Warwick Technology Park, Warwick, U.K., no. 3, 2012.

[9]. F. A. S. Neves, M. Carrasco, F. Mancilla-David, G. M. S. Azevedo, and V. S. Santos, "Unbalanced grid fault ride-through control for singlestage photovoltaic inverters," IEEE Trans. Power Electron., vol. 31, no. 4, pp. 3338–3347, Apr. 2016.

[10].G. Lammert, D. Premm, L. D. P. Ospina, J. C. Boemer, M. Braun, and T. Van Cutsem, "Control of photovoltaic systems for enhanced short-term voltage stability and recovery," IEEE Trans. Energy Convers., vol. 34, no. 1, pp. 243–254, Mar. 2019.

[11].P. Chao, W. Li, S. Peng, X. Liang, D. Xu, L. Zhang, N. Chen, and Y. Sun, "A unified modeling method of photovoltaic generation systems under balanced and unbalanced voltage dips," IEEE Trans. Sustain. Energy, vol. 10, no. 4, pp. 1764–1774, Oct. 2019.

[12].M. Mirhosseini, J. Pou, and V. G. Agelidis, "Single- and two-stage inverter-based grid-connected photovoltaic power plants with ride-through capability under grid faults," IEEE Trans. Sustain. Energy, vol. 6, no. 3, pp. 1150–1159, Jul. 2015.

[13].1200 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report: Southern California Event: August 16, 2016, North Amer. Electr. Rel. Corp., Atlanta, GA, USA, 2017.

[14].900 MW Fault Induced Solar Photovoltaic Resource Interruption Disturbance Report: Southern California Event: October 9, 2017, North Amer. Electr. Rel. Corp., Atlanta, GA, USA, Feb. 2018.

[15].H. Shin, J. Jung, S. Oh, K. Hur, K. Iba, and B. Lee, "Evaluating the influence of momentary cessation mode in inverter-based distributed generators on power system transient stability," IEEE Trans. Power Syst., vol. 35, no. 2, pp. 1618–1626, Mar. 2020.

[16].H. Shin, J. Jung, and B. Lee, "Determining the capacity limit of inverterbased distributed generators in high-generation areas considering transient and frequency stability," IEEE Access, vol. 8, pp. 34071–34079, Feb. 2020.

[17].M. K. Hossain and M. H. Ali, "Transient stability augmentation of PV/DFIG/SG-based hybrid power system by nonlinear control-based variable resistive FCL," IEEE Trans. Sustain. Energy, vol. 6, no. 4, pp. 1638–1649, Oct. 2015.

[18].L. Wang, Q.-S. Vo, and A. V. Prokhorov, "Stability improvement of a multimachine power system connected with a large-scale hybrid windphotovoltaic farm using a supercapacitor," IEEE Trans. Ind. Appl., vol. 54, no. 1, pp. 50–60, Jan. 2018.

[19].M. Edrah, K. L. Lo, and O. Anaya-Lara, "Impacts of high penetration of DFIG wind turbines on

rotor angle stability of power systems," IEEE Trans. Sustain. Energy, vol. 6, no. 3, pp. 759–766, Jul. 2015.

[20]. IEEE Standard for Synchrophasor Data Transfer for Power Systems, IEEE Standard C37.118.2, Dec. 2011.

[21]. G. Dileep, "A survey on smart grid technologies and applications," Renew. Energy, vol. 146, pp. 2589–2625, Feb. 2020.

[22]. ABB Central Inverters. PVS980-58 Central Inverters—Hardware Manual. Accessed: Feb. 10, 2021. [Online]. Available: https://new.abb.com/news/detail/23761/abb-launches-next-generation-central-inverterwith-unique-cooling-capabilities

[23]. AVX. (Jun. 2015). FFLC Series Film Capacitors. [Online]. Available: http://www.avx.com/products/film-capacitors/medium-power-filmcaps/fflc/

[24]. H. Akagi, S. Ogasawara, and H. Kim, "The theory of instantaneous power in three-phase four-wire systems: A comprehensive approach," in Proc. Conf. Rec. IEEE Ind. Appl. Conf. 34th IAS Annu. Meeting, vol. 1, Oct. 1999, pp. 431–439.

[25]. F. A. S. Neves, M. C. Cavalcanti, H. E. P. D. Souza, E. J. Bueno, and M. Rizo, "A generalized delayed signal cancellation method for detecting fundamental-frequency positive-sequence three-phase signals," IEEE Trans. Power Del., vol. 25, no. 3, pp. 1816–1825, Jul. 2010.

[26]. P. S. N. Filho, T. A. D. S. Barros, M. V. G. Reis, M. G. Villalva, and E. R. Filho, "Strategy for modeling a 3-phase grid-tie VSC with LCL filter and controlling the DC-link voltage and output current considering the filter dynamics," in Proc. IEEE 16th Workshop Control Modeling Power Electron. (COMPEL), Jul. 2015, pp. 1–8.

[27]. L. Limongi, R. Bojoi, G. Griva, and A. Tenconi, "Digital current-control schemes," IEEE Ind. Electron. Mag., vol. 3, no. 1, pp. 20–31, Mar. 2009.

[28]. R. C. Neto, F. A. Neves, and H. E. D. Souza, "Complex controllers applied to space vectors: A survey on characteristics and advantages," J. Control, Automat. Elect. Syst., vol. 31, no. 5, pp. 1132–1152, Jul. 2020.

[29]. P. S. Flannery and G. Venkataramanan, "A fault tolerant doubly fed induction generator wind turbine using a parallel grid side rectifier and series grid side converter," IEEE Trans. Power Electron., vol. 23, no. 3, pp. 1126–1135, May 2008.

[30]. A. Mullane, G. Lightbody, and R. Yacamini, "Wind-turbine fault ride-through enhancement," IEEE Trans. Power Syst., vol. 20, no. 4, pp. 1929–1937, Nov. 2005.

[31]. J. Chen, L. Jiang, W. Yao, and Q. H. Wu, "Perturbation estimation based nonlinear adaptive control of a full-rated converter wind turbine for fault ride-through capability enhancement," IEEE Trans. Power Syst., vol. 29, no. 6, pp. 2733–2743, Nov. 2014

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