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# Solar PV-Fed Multilevel Inverter with Series Compensator for Power Quality Improvement in Grid Connected Systems

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***Abstract:** Power quality problems arise as a result of RES integration into the grid. Voltage fluctuations, harmonic distortion, and spikes all impact customers as power quality issues on the grid. A cheap series compensator, such as the Dynamic Voltage Restorer (DVR), is the best approach to fix these problems. In order to enhance the grid's power quality, this research introduces a novel multilayer inverter that uses solar PV as a distributed voltage rectifier. The main objective of the proposed work is to enhance power quality through the development of a DVR that simultaneously functions as an integrated 23-level multilevel inverter. Beyond that, the boost converter has an improved INC-MPPT implementation. Despite their numerous benefits, multilayer inverters encounter reliability concerns such as reduced total harmonic distortion (THD) and fewer components. The suggested design has the potential to produce 23 distinct output voltage levels by use of asymmetrical DC sources. An inverter that is both smaller and cheaper with fewer parts is one of the advantages of the MLI. On top of that, the dq reference frame rotation adjustment is well studied mathematically. To test the DVR's flexibility with an equal load, simulation approaches are used. The simulation results of the suggested structure are generated using MATLAB/Simulink. Results from the Fuzzy Logic System show that the proposed technique improves power quality and compensates better for voltage sag.*

***Keywords:** PV Array, DVR, PQ, MPPT, Grid System.*

## 1. INTRODUCTION

The use of power electronic devices is on the rise in power systems, particularly distribution systems. Customers use them as load interfaces, and the grid uses them as an option. One explanation for the latter is the growing concern about power quality, which refers to the accuracy and purity of voltages and currents as they are measured in relation to ideal power

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sources. On the one hand, power electronics enabled loads have higher standards for power quality than traditional loads. Concurrently, these loads are known to cause an increase in power quality problems, which in turn pollutes the power system. If you want better power quality, using power regulating devices is one option. A photovoltaic (PV) system is going to be a leading renewable energy option in the not-too-distant future.

In today's intelligent world, digital, electronic, and non-linear devices—those controlled by microprocessors—are ubiquitous across all markets. Almost without exception, these gadgets are completely inoperable in the event of a sudden interruption in the power supply. Device failure, programme corruption, power supply difficulties, regular resets, loss of memory, UPS warnings, and overheating of distribution networks for electricity are all symptoms of poor power quality. Given these facts, PQ's importance has grown throughout the years. Anxieties over the power quality of delicate loads has arisen from the fourfold increase in their use over the past several years in settings such as healthcare facilities, schools, prisons, etc. Problems with voltage spikes, dips, harmonics, transients, flickers, fluctuations, and interruptions are at the heart of power quality difficulties. These reliability & voltage fluctuation concerns must be prevented by the sensitive and important loads. Regarding this, several solutions have been proposed, with Custom Power Devices (CPDs) being the most effective and efficient option for reducing voltage fluctuations and compensating for them.

## DVR Configuration

When it comes to power quality issues, voltage swells and dips are the most noticeable disruptions. A new generation of power electronic converter-based bespoke power devices has emerged to address these issues. The dynamic voltage restorer is the most cost-effective and efficient component inside these devices for protecting sensitive loads from voltage dips and spikes. The DVR is a series-connected device that detects voltage sag or swelling issues and injects regulated voltage into the system; it is situated between the sensitive load and the grid in the system. There is some evidence that it can mitigate transient voltage while fault current restrictions, and it can also be used to compensate for harmonics. Using an injection transformer, DVR restores power quality by injecting a regulated voltage in series to the power source voltage in phase. You can see the fundamentals of a standard DVR in Figure 4.1. The four main types include inverters, dc-link capacitors, filter and injection transformers, and the like. Changing direct current storage into alternating current requires an inverter system. To remove the undesirable harmonic components produced by the inverter, a passive filter is used. This is how the inverter's pwm output is transformed into a sinusoidal waveform. To supply the DC energy needed, another part is an energy storage unit, which may be anything from batteries to super capacitors to SMES, etc. Finally, the load & the system are isolated by the transformer, which injects regulated voltage.

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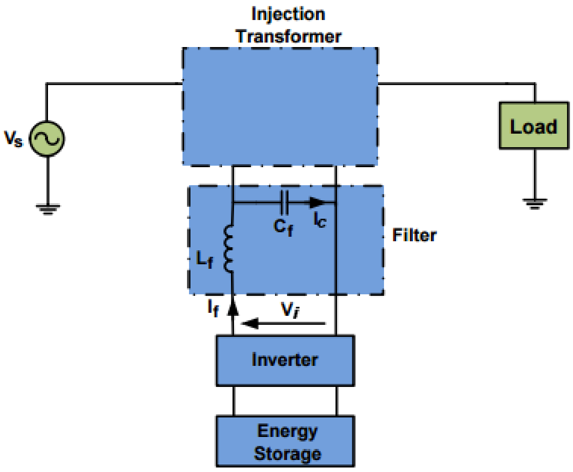


Fig.3.1: DVR structure

## 2. SIMULATION RESULTS

Improving the voltage profile is the metric by which the proposed multilayer inverter solar PV supplied DVR is assessed. The MATLAB/Simulink platform is used to display the results.

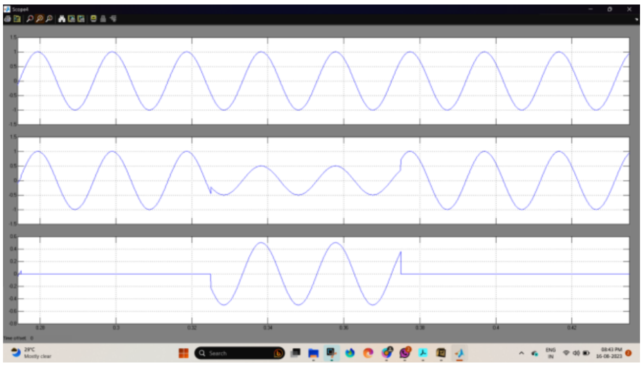

Fig.4.1: Simulation results of Source, Injected, and Load voltages at sag condition. (Existing system)

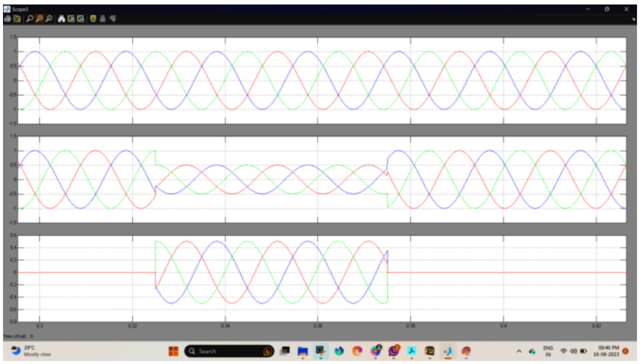

Fig.4.2: Simulation results of Source, Injected, and Load voltages at 0.5pu of sag condition. (Existing system)

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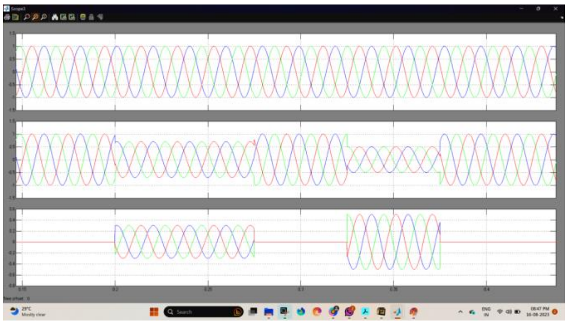

Fig.4.3: Simulation results of Source, Injected, and Load voltages at 0.7pu and 0.5pu sag mode. (Existing system)

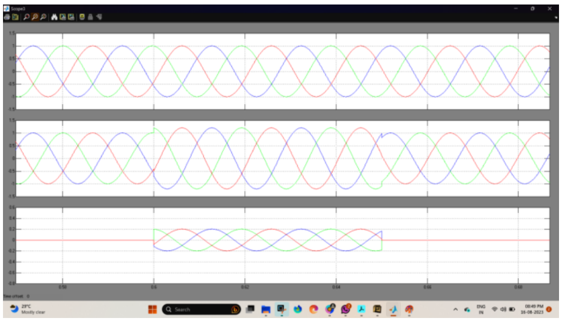

Fig.4.4: Simulation results of Source, Injected, and Load voltages at 1.2pu swell mode. (Existing system)

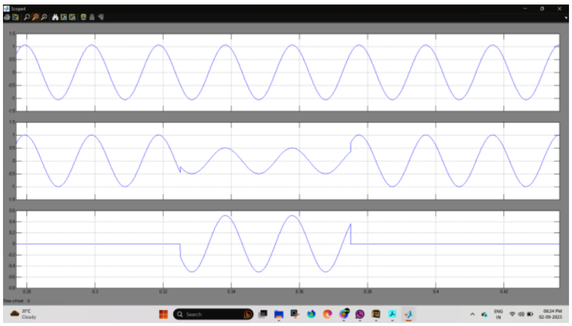

Fig.4.5: Simulation results of Source, Injected, and Load voltages at sag condition. (Proposed system)

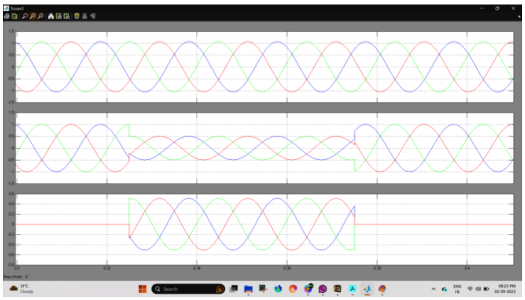

Fig.4.6: Simulation results of Source, Injected, and Load voltages at 0.5pu of sag condition. (Proposed system)

 

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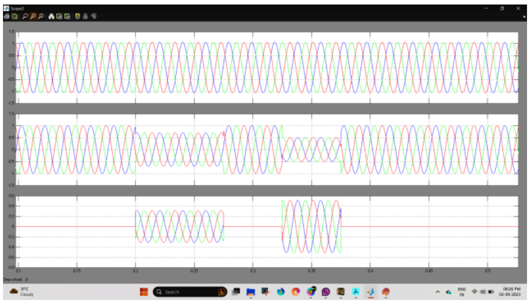

Fig.4.7: Simulation results of Source, Injected, and Load voltages at 0.7pu and 0.5pu sag mode. (Proposed system)

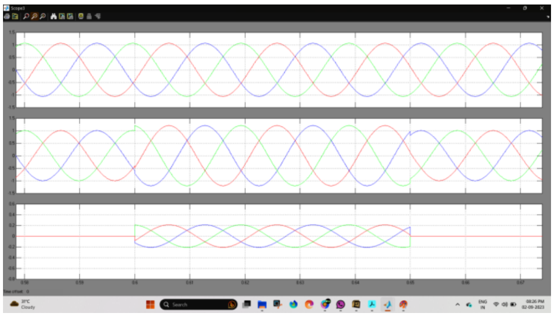

Fig.4.8: Simulation results of Source, Injected, and Load voltages at 1.2pu swell mode. (Proposed system)

This investigation compares the voltage at the load point with 0.5pu of sag. As seen in the figures, the suggested DVR injects the correct voltage and keeps the load voltage profile. Although Figures depict a three-phase voltage profile of the DVR, Figures only show a one-phase voltage profile at 0.5pu of sag condition. The voltage THD at the load side, when the DVR is in sag mode, is shown in the figure. By comparing the load point reference voltage to an overload at time intervals of 0.2 to 0.285 seconds with 0.7pu and 0.3 to 0.385 seconds with 0.5pu, a double voltage sag mode is produced. As seen in Figure, the suggested DVR keeps the load voltage profile constant and injects the correct voltages. At intervals ranging from 0.3 seconds to 0.365 seconds, a swell mode is generated in this test. The load point reference voltage is affected by 1.2 pu of swelling. Figure shows the suggested DVR in action, compensating for the correct voltage while keeping the load voltage profile intact.

## 3. CONCLUSION

This paper proposes a PV-fed MLI-DVR that uses an asymmetrical 23-level MLI in conjunction with a rotating dq standard frame controller. We use MATLAB/Simulink to create a new kind of multilayer inverter. The suggested MLI achieves a synthesised output voltage with a low total harmonic distortion (THD) by making use of fewer circuit elements. In order to keep the DC connection voltage steady, the suggested solution effectively reduces voltage sag. By utilising the INC MPPT approach, one may maximise the power collected from PV modules. This paper presents a comprehensive analysis of the suggested MLI-DVR and compares it to the current topologies. The results show that the suggested system

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compensates for voltage sag more efficiently. Since the suggested technology works so well, it can be used in HVDC & FACTS devices going forward.

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