# VALIDATION AND SIMULATION OF DYNAMIC VOLTAGE CONDITIONER FOR LOW VOLTAGE DISTRIBUTION SYSTEM

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## ABSTRACT

For electric companies and customers alike, power quality has grown to be a key problem. The negative impacts of poor power quality in several nations have led to the annual loss of many billions of dollars. This is owing to the negligence of most industries in failing to upgrade existing facilities, which results in extremely high costs due to product loss, lost production time, clean-up expenses, and process recalibration. One of the main reasons of power quality issues like voltage disruptions on the supply network is the employment of complicated and sensitive new technologies in electric equipment. Power electronic equipment is more vulnerable to voltage fluctuations, which has a significant impact on voltage fluctuations. It is challenging to identify the sources leading to power quality problems. Factors for the causes of most power quality problems are beyond the control of utilities and can never be totally eliminated. The Proposed system is validated with simulation study and experimental laboratory tests. Some simulation and experimental results are illustrated to show the prototype device’s performance.

Key Words: APF, UPQC, DSP, IGBT.

## INTRODUCTION

Power Quality (PQ) has grown significantly in importance over the past several years, particularly on the side of electrical distribution. The physical qualities of the electrical supply that is given under typical operating settings that do not interfere with or upset the user's processes are referred to as power quality, according to international standards. The tripping of sensitive electronic equipment due to voltage disturbances (harmonics, sags, and swells) can have severe effects in industrial operations, such as unanticipated outcomes or the termination of the entire production line. These occurrences are frequent in industrial sectors and cause significant economic harm. Modern plants are using more and more power electronics-based machinery, which creates a load that is sensitive and harmonics-producing by nature. Interestingly, these equipment’s generally produce distortion in currents and/or voltages. Thus, there is a new trend to install mitigating equipment’s that can serve the dual purpose, to both the utility as well as to the customer. Thus, with the implementation of Custom Power Devices in the distribution side, Power Quality is enhanced. One of the most effective solutions to power quality issues in the distribution side is the installation of Unified Power QualityConditioner (UPQC). Unified power quality conditioners that can pact with both current and voltage type power quality issues can control load voltage, mitigate voltage transients, remove input current harmonics and rectify input power factor over a wide operating range. Each unified power quality conditioner acts as an APF (Active Power Filter) and a DVR (Dynamic Voltage Restorer) with their DC links shared with the same energy storage devices. A current controller is used to regulate the input current of the APF and thus shape the current drawnfrom the AC mains. A voltage controller is used to control the DVR to regulate the load voltage and provide sufficient voltage sag or swell ride through capacity. Three typical structures for single phase UPQCs, including full- bridge, three -leg and half-bridge structures need to be presented. The full-bridge structure consists of two H-bridge inverters having eight switching devices with or without an isolation transformer. The isolation transformer is used to inject necessary compensating voltage between the grid and the load. With the low-frequency isolation transformer, the structure is bulky in size, heavy in weight, and costly. The way to achieve fast dynamic behaviour's is also one of the design challenges. The three-leg structure consists of two H-bridge inverters with one leg shared. As no isolation transformer is required, the three-leg structure is more cost effective and compact than the full-bridge structure. However, the shared leg causes mutual coupling between the two inverters, and thus introducesoperational constraints in shaping the incoming current and stabilizing the load voltage. A sophisticated modulation technique is used to synchronize the operations of the two inverters and deal with the coupling effects. Special considerations are taken to optimize energy efficiency and harmonic performance under different grid and load conditions. The half-bridge structure consists of two half-bridge inverters and one isolation transformer. Its operation is similar to the operation of the full-bridge one, except that the full bridge is replaced by a half bridge with the voltage rating doubled. Its structure requires a smaller number of switching devices, but the isolation transformer still limits the power density of the system.

## PROBLEM FORMULATION

Every circuit which has advantages will also have few disadvantages. A DVR has limited capabilities and the DVR will most likely to face voltage sag outside the range of full compensation. The voltage injected can with an ideal DVR be done instantly, but practical DVRs have a finite response-time and other factors may favour a smooth change from one operating point to another. For the DVR a slow change to stationary operating point willreduce the risk of in rush currents and saturation of the transformer. From a load point of viewa fast change of the pre-sag voltage will make the voltage sag unseen. If a phase change is initiated to minimize the energy storage depletion a slow change to an adequate stationary operating point may prevent severe transients and in worst case load tripping. All the limits should be taken into consideration in the control strategy. Some of the limitations of DVR are:

**Voltage limit:** The design is limited in the injection capability to keep the cost down and to reduce the voltage drop across the device in standby operation.

**Current limit:** The DVR has a limitation in current conduction capability to keep the cost down.

**Power limit:** Power is stored in the DC link, but the bulk power is often converted from supplyitself or from a larger DC storage. An additional converter is often used to maintain a constant DC-link voltage and rating of the converter can introduce a power limit to the DVR.

## RESEARCH OBJECTIVES

- To redesign the circuit by additional protection circuit in the DVC section for theprotection of IGBT by increasing the frequency from 12khz to 20 khz.
- By changing the TMS DSP controller with some other DSP controller to make thecircuit cost effective
- To check the performance of the circuit for the three-phase supply. The system will betested for a power quality in the three-phase supply.
- Comparison of proposed system with the existing ones.

## RESEARCH METHODOLOGY

This research work will adopt a research methodology that combines the theory model with empirical evaluation and refinement of the proposed scheme on MATLAB simulation tool. MATLAB is a useful high-level development environment for systems which require mathematical modelling, numerical computations, data analysis, and optimization methods. This is because MATLAB consists of various toolboxes, specific components, and graphical design environment that help to model different applications and build custom models easier.

Moreover, the visualization and debugging features of MATLAB are simple. The researchmethodology includes:

1. To Study of current existing system.
2. To implement new circuit in MATLAB simulator.

3. To check the reliability of system for fast switching
4. To check the stability and efficiency of system.
5. Validation of the results

**RESULTS**

The proposed work is simulated using the popular MATLAB software tool and the overallsimulation is presented in the following screen shots:

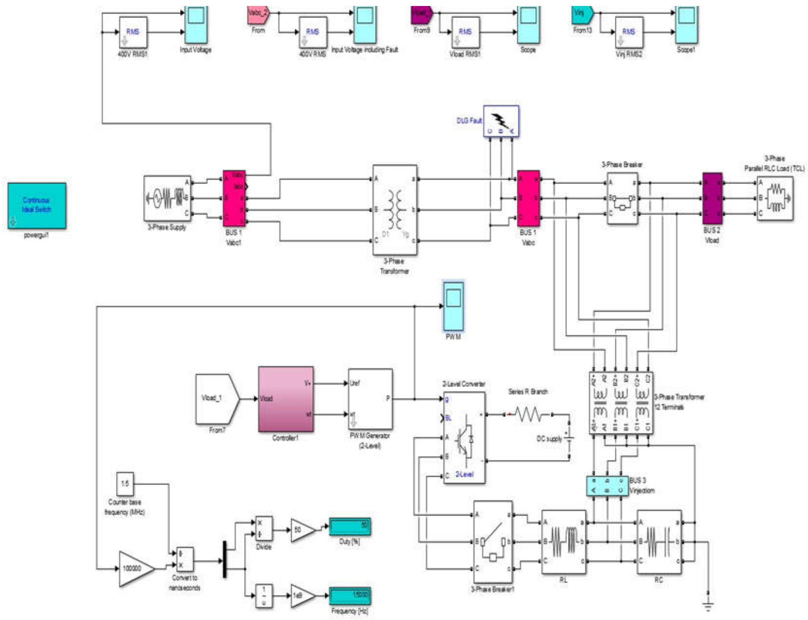


Figure 1.1: Model of the proposed work

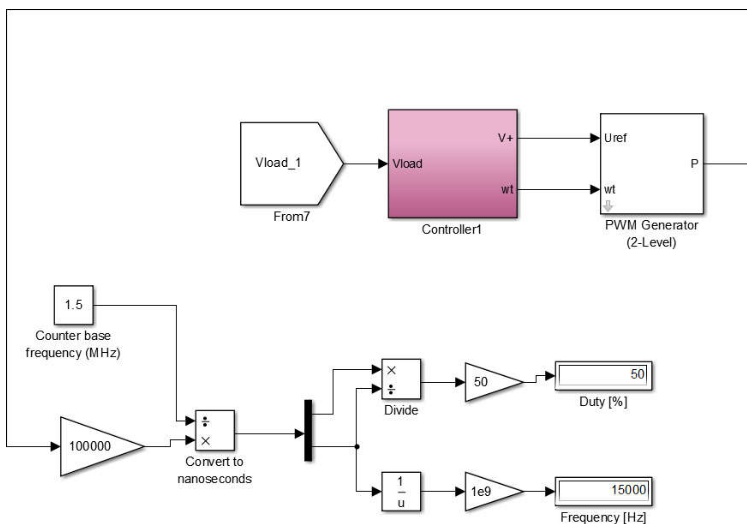


Figure 1.2: The PWM Frequency

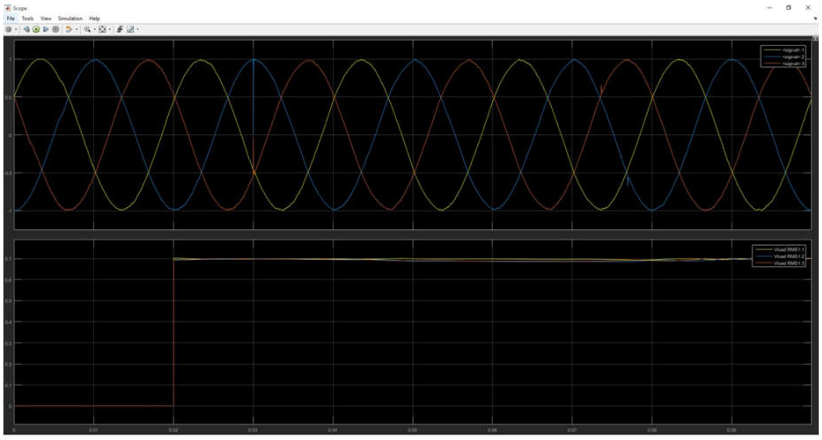

Figure 1.3: Load Voltage representation

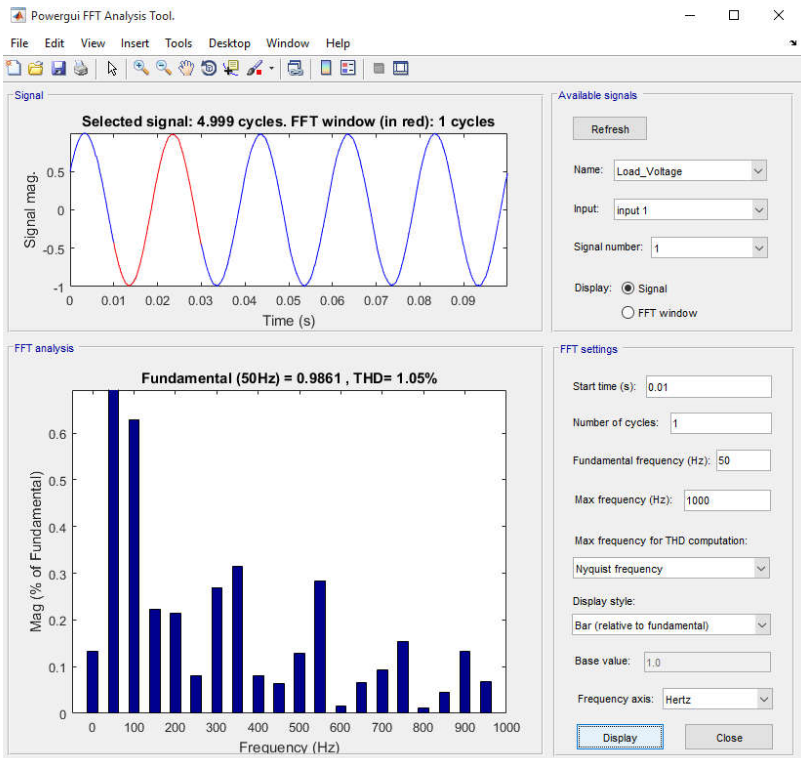

Figure 1.4: Load Side THD

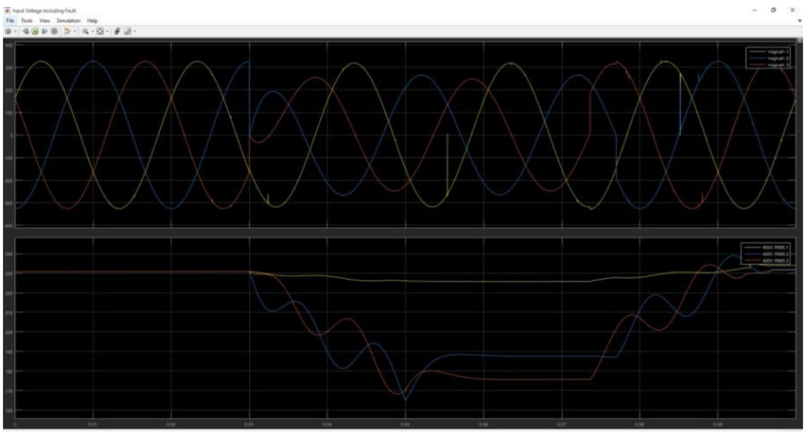
Figure 1.5: Input Voltage Fault

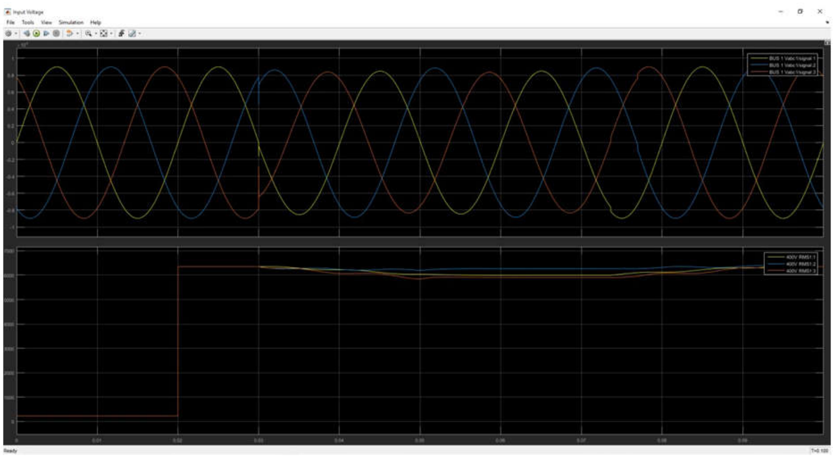
Figure 1.6: Input Voltage

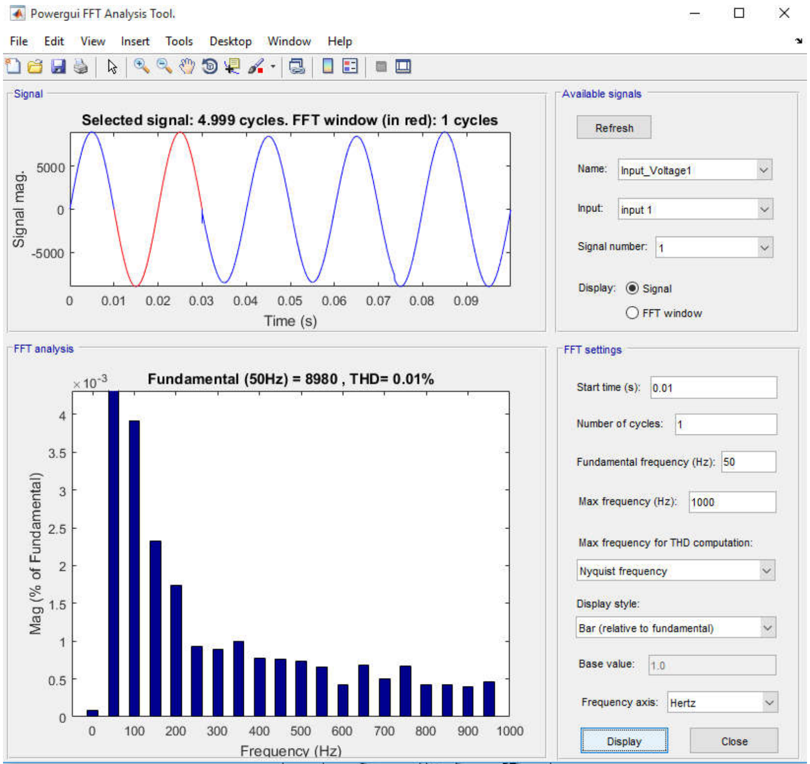

Figure 1.7: Input Side THD

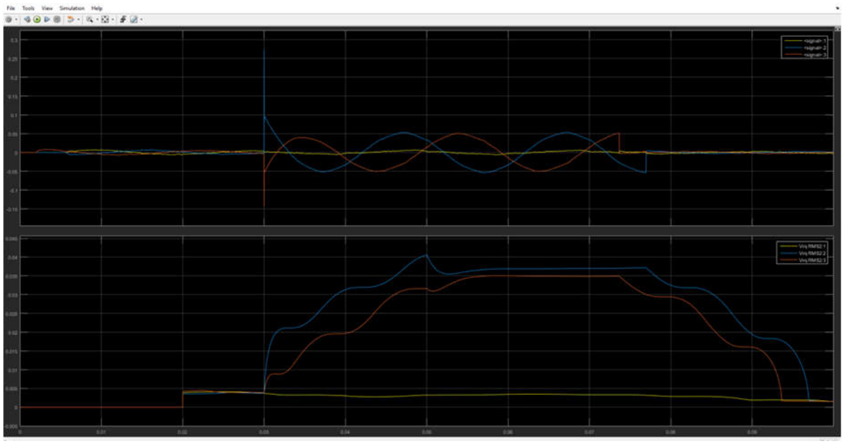
Figure 1.8: Injected Voltage

## CONCLUSION

A dynamic voltage conditioner is an active voltage conditioner that can handle both long events and short, quick events like those found in a typical DVR. This paper outlines a control strategy for producing DVC reference voltage while taking into account its constraints. Additionally, a single phase design can lower the initial cost of the device and is more suitable with LV distribution and household single-phase loads. Results indicate that the gadget performs well and may significantly raise the PQ level of the deployed distribution smart grid network. The suggested DVC can allow the system operator freedom to relocate any troublesome single-phase loads to a specified phase, which is crucial for today's contemporary network.

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