Stability of the Load voltage (UPQC)

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Abstract—**The aim of this article is to present a new solution to improve the load voltage using Unified Power Quality Conditioner (UPQC). The series active filter (SAF) which is used to compensate voltage disturbances and the parallel active filter (PAF) which is used to compensate current disturbances and reactive power. The UPQC is the combination of both SAF and PAF. The obtained results are interesting and show the efficiency of the UPQC to solve power qualities problems.**

Keyswords- Serie active filter, Parallel active filter, UPQC, PI controller, Compensation.

I. INTRODUCTION

In order to improve the quality of electric power in the network by ensuring the availability and quality of the voltage wave load, several solutions remediation grids summers have been suggested in the literature. Those that best meet industrial constraints are active compensators. The series compensator can compensate harmonic voltages, unbalanced voltage... . UPQC can perform the functions of both series and shunt active filters, allowing the compensation of all disturbances of the voltage and the current existing on the network.

II. PROBLEMS OF THE QUALITY OF ENERGY

The problems of power quality can affect the fellowing [1]:

- The amplitude
- The waveform
- Frequency
- The symmetry of the three phases system.

So we can restrict our study of the most trouble phenomena in the field of power quality such as:

A. Voltage dips and short interruption

A voltage dip is a reduction in the amplitude of the voltage (from 10% to 90%) of the nominal voltage for duration of 10 milliseconds to few seconds. This decrease in amplitude may exceed 90% of the rated voltage, it is then a brief break [2],[3].

B. voltage swell

Voltage swell is higher amplitude variations of the nominal voltage [4].

C. Unbalanced voltage.

The unbalanced voltage is the simultaneous voltage amplitudes or phase changes that are not identical in the three phases [5]. Solutions implemented:

- Passive filter.
- Active Filter.

III. ACTIVE FILTER

1. Series Active Filter

The series active filter (SAF) is a solution to compensate for disturbance voltage, harmonics, unbalanced voltage dips and surges. These disturbances are usually found their origins in the network itself but can sometimes be caused by the charges themselves [6],[7].

2. L'UPQC

The UPQC (Unified Power Quality Conditioner) is a universal solution for compensation based on the simultaneous operation of parallel and series active filters. This new topology is called parallel-series combination of assets. The UPQC has the combined advantages of serial and parallel active filters [7].

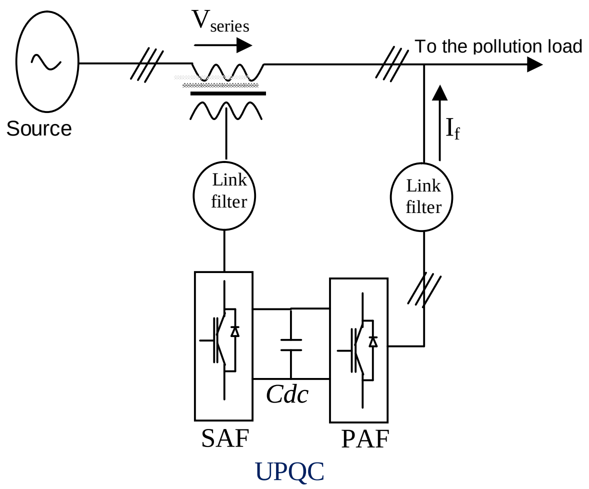

Fig. 1. General configuration of UPQC

The UPQC consists of two parts:

1. *Power part*

The powerful part is composed of :

A. *Link filter*

Ensure the dynamic current and prevent components due to the commutations spread on the grid.

B. *Transformer injection*

Allow injection voltage in series with the main voltage by introducing the desired degree of conversion to the voltage produced by the inverter.

C. *Energy storage circuit*

The energy storage on the DC side is done by a capacitive storage system represented by a capacitor which acts as a voltage source.

2. *Control part*

The control part is made up of:

A. *Identification of disturbances*

The application of the synchronous reference frame (Synchronous Reference Frame, SFR) based on the extraction is harmonic, in the three load currents I_a, I_b and I_c.

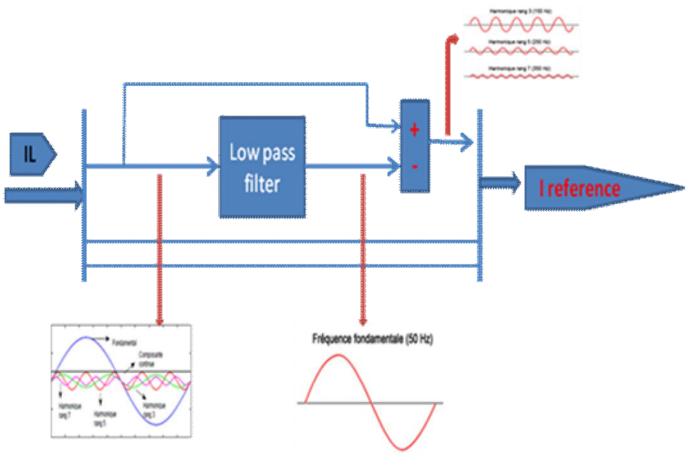

Fig. 2. Method Synchronous Reference Frame (SRF).

B. *Inverter control*

The purpose of the inverter control, is to generate the command of closing and opening of the switches, so that the output voltage and current as accurately as possible following the instructions in module and phase.

C. *Bus DC regulation*

The average voltage across the capacitor must be maintained at a constant value.

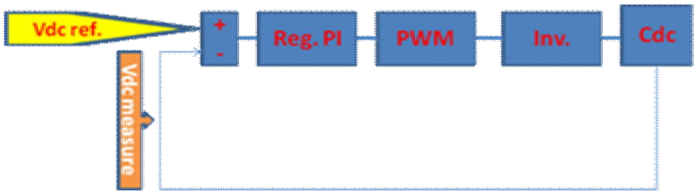

Fig. 3. Continues bus control

IV. STUDY UPQC

1. *Regulation*

For the determination of the parameters of the PI controller to adjust the control loops parallel and series active filters were used method of taxation phase for the determination of controller parameters DC bus, using the pole placement method [8],[9].

A. *Control Loop filter parallel*

If the size is controlled I_f the current supplied by the parallel active filter, the control scheme represented as follows [8]:

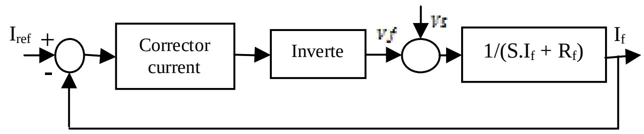

Fig. 4. Control Loop filter parallel

B. *Control loop filter series*

The series filter is considered a compensating voltage generator represented as follows [8].

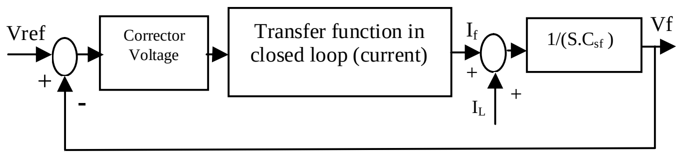

Fig. 5. Control loop filter series

C. *Control loop of the DC bus of the inverter*

Following a gap between V and $V_{dcréf}$ as shown in Figure 6, the power output of the controller is added to the active power fluctuation and gives rise to a fundamental active current and voltage correcting [10].

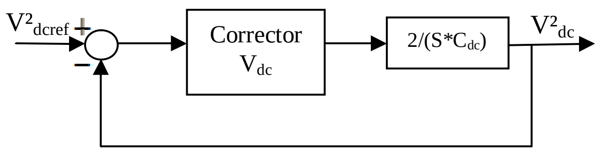

Fig. 6. Control loop of the DC bus of the inverter

2. *Correction tensions :*

Correction tensions in UPQC proposed method follows (Fig. 7) [7]:

Three phase voltage :

$$V1(t)=sqt(2)\sin(\omega t)$$

$$V2(t)=sqt(2)\sin(\omega t - 2\pi/3) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$V3(t)=sqt(2)\sin(\omega t + 2\pi/3)$$

For this voltage we used abc transformation to dqo by an amplitude equal to 311V:

$$V_a = V_d\sin(\omega t) + V_q\cos(\omega t) + V_0$$

$$V_b = V_d\sin(\omega t - 2\pi/3) + V_q\cos(\omega t - 2\pi/3) + V_0 \ldots\ldots\ldots \quad (2)$$

$$V_c = V_d\sin(\omega t + 2\pi/3) + V_q\cos(\omega t + 2\pi/3) + V_0$$

Comparing this voltage with the source voltage (V_source), the comparison will gives the voltage disturbance voltage injected or view (Fig. 7).

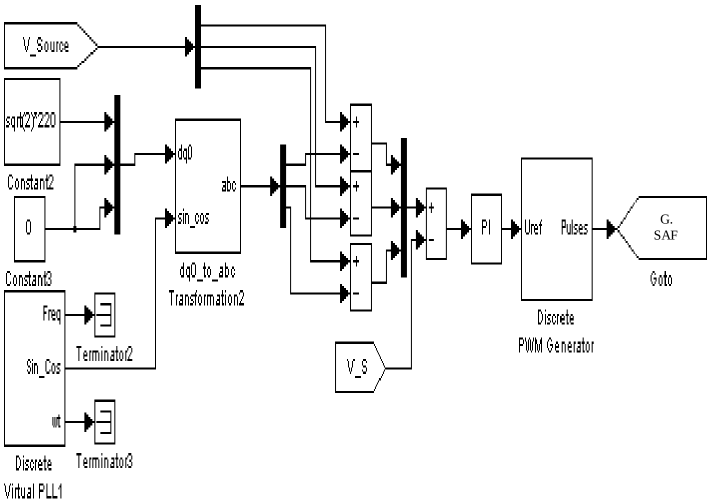

Fig. 7. Simulation scheme of voltage control

V. SIMULATION

The theoretical study carried out by Matlab-Simulink software that supports linear and nonlinear systems, modeled in continuous time, and time sampled. Dynamical systems are simulated by diagrams given in block form [6],[7].

Parameters of UPQC:

- Simple effective network voltage Vs = 220V, frequency f = 50Hz network.
- Line resistance R = 0.001Ω, the inductance of the line L_l = 0.054mH.
- Active power of the nonlinear load P = 8 kW, reactive power Q = 500var.
- Bus continues V_{dc} = 735.6V, C_{dc} = 0.0087 F, $K_{P\text{-}DC}$= 2.2883; $K_{I\text{-}DC}$ = 308.0956/sec.

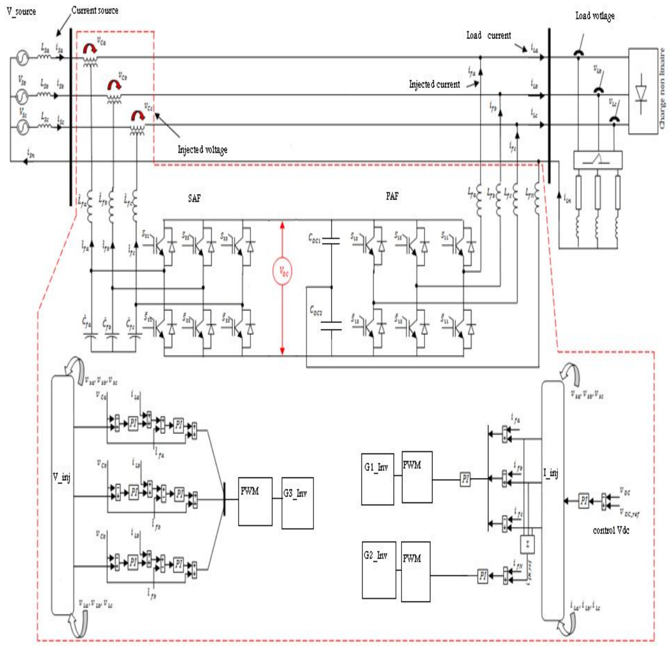

Fig. 8. UPQC Simulation scheme.

Three phase voltage sag of 30% (0.1s to 0.2s), voltage harmonic (0.3s to 0.4s), voltage swells of 30% (0.5s to 0.6s) and voltage interruption (0.7s to 0.8s) are simulated and shown in Figure 9.

Figure 10 illustrates the action of the UPQC about the three phase voltage sag, voltage harmonic, voltage swells and voltage interruption. Indeed, after the injection of voltage and current figure 13 and figure 14. The charging voltage obtained was compensated and the source current has become sinusoidal figure 12 with THDv = 0.15% and THDi = 1.02%.

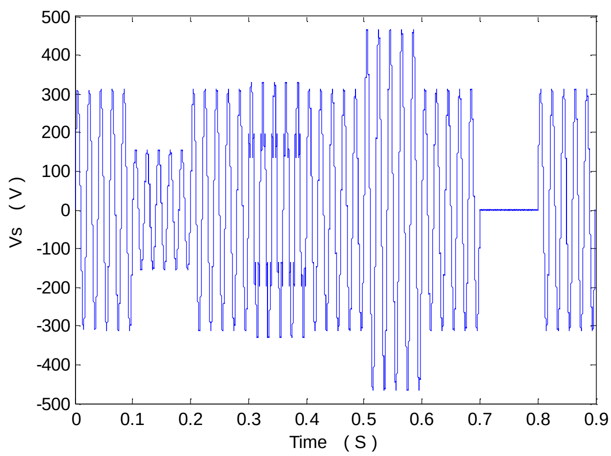

Fig. 9. Source voltage

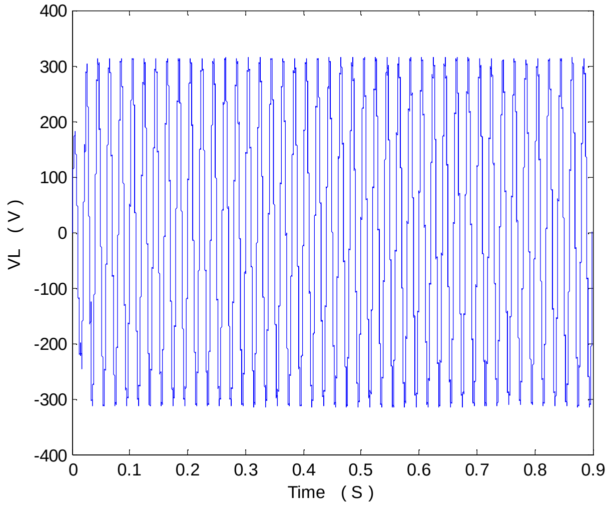

Fig. 10. Load voltage

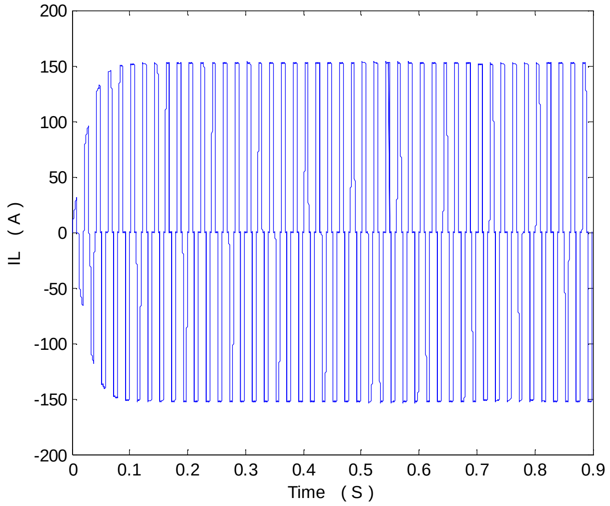

Fig. 11. Load current

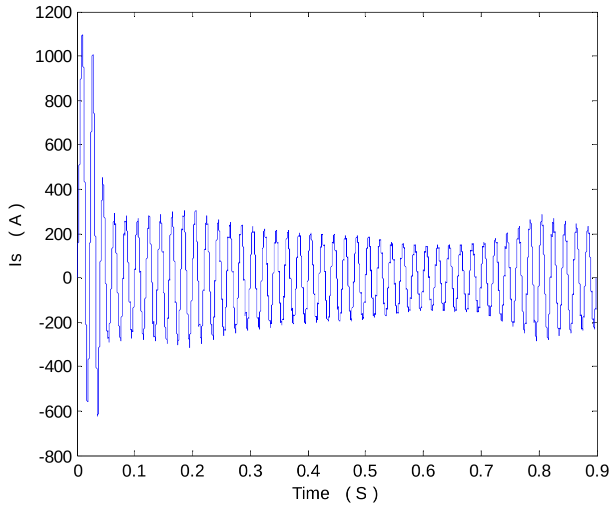

Fig. 12. Current source

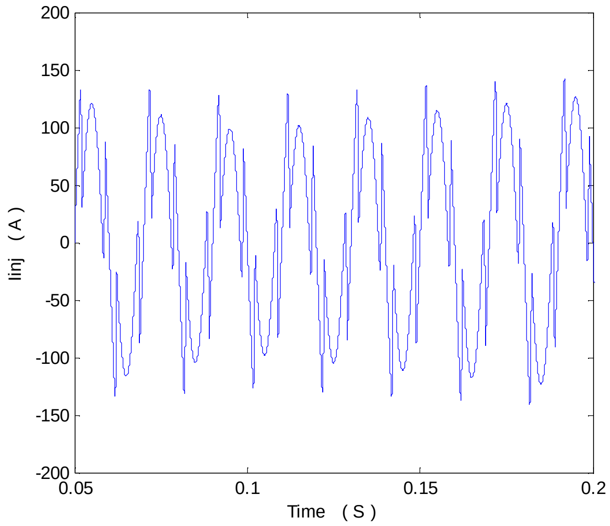

Fig. 13. Injected current

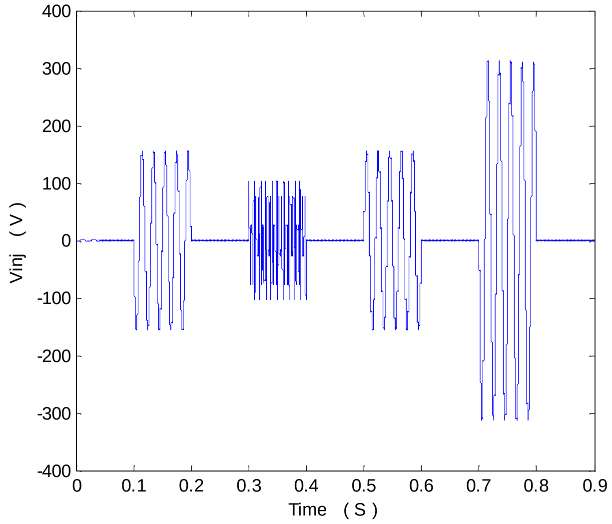

Fig. 14. Injected voltage

VI. Conclusion

The work presented here is part of the search for new solutions to improve the quality of the electrical energy into the grid.

The active filter combined series-parallel (UPQC) has been proposed as a general solution to compensate for any disturbances in current and voltage, the active filter series whose objective was the compensation disturbance voltage.

The simulation results obtained show that the UPQC compensation allows simultaneous disturbances of current and voltage with good performance.

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