NON-LINEAR AND UNBALANCED THREE-PHASE LOAD STATIC COMPENSATION WITH ASYMMETRICAL AND NON SINUSOIDAL SUPPLY

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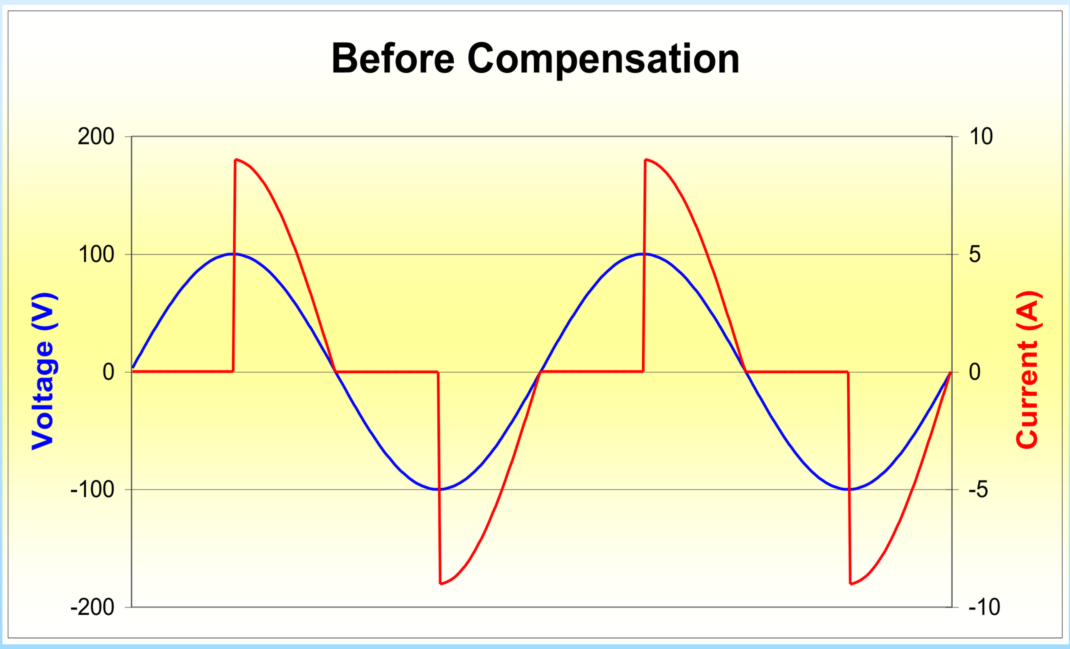
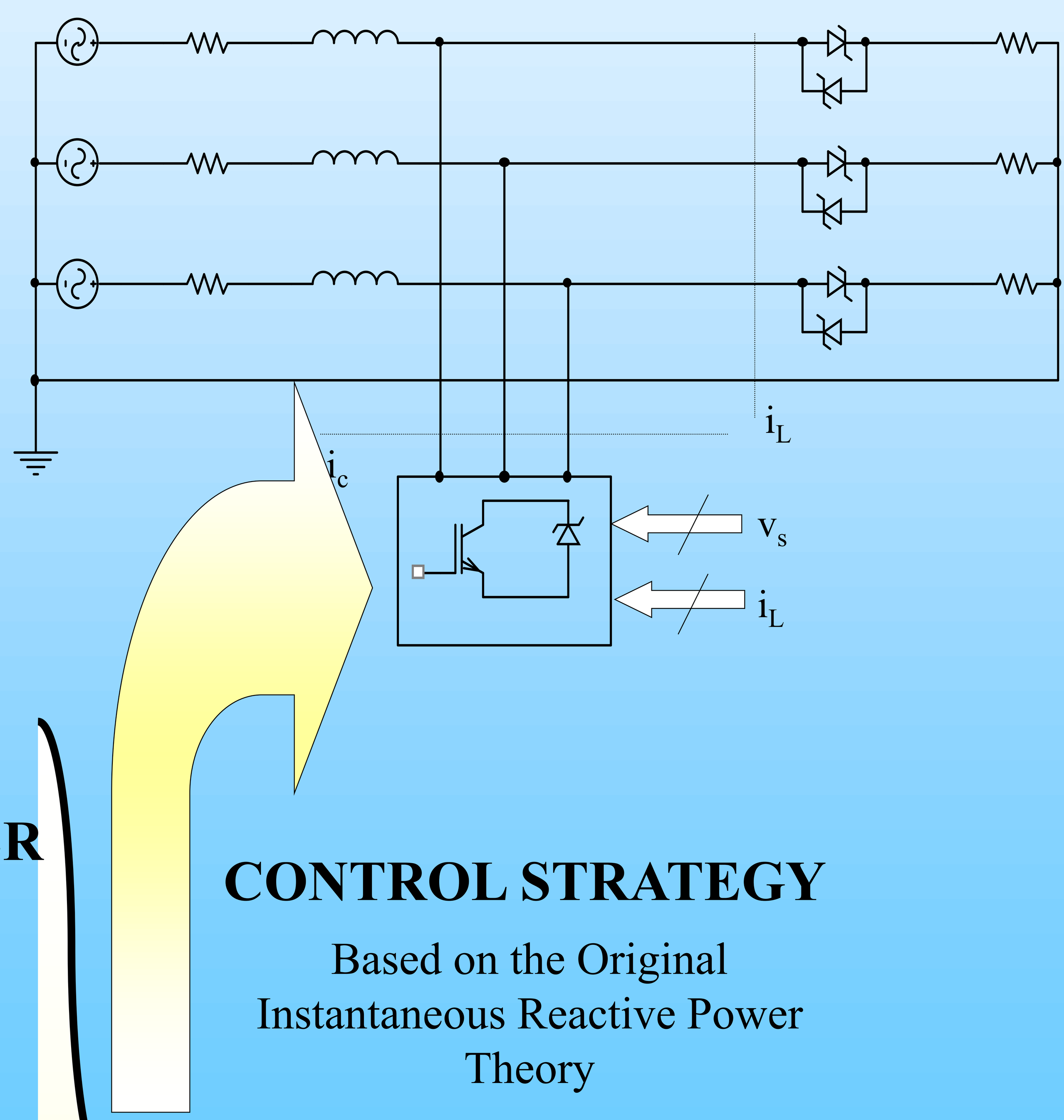
Abstract

P-q theory has been widely used to control active power filters since its formulation in 1983. The compensation strategy used by the p-q theory users has not suffered modification; so it is used the constant power compensation strategy. In this way, the supply instantaneous power after compensation is constant. This kind of compensation strategy has obtained good results in the case of balanced and sinusoidal voltages, however it has not been appropriate in the case of unbalanced or non sinusoidal voltages. In this paper it has been researched about the modifications necessary, into the p-q theory frame, to get control strategies which allow to attack the unit power factor compensation or the balanced and sinusoidal currents compensation.



BEFORE COMPENSATION



CONTROL STRATEGY

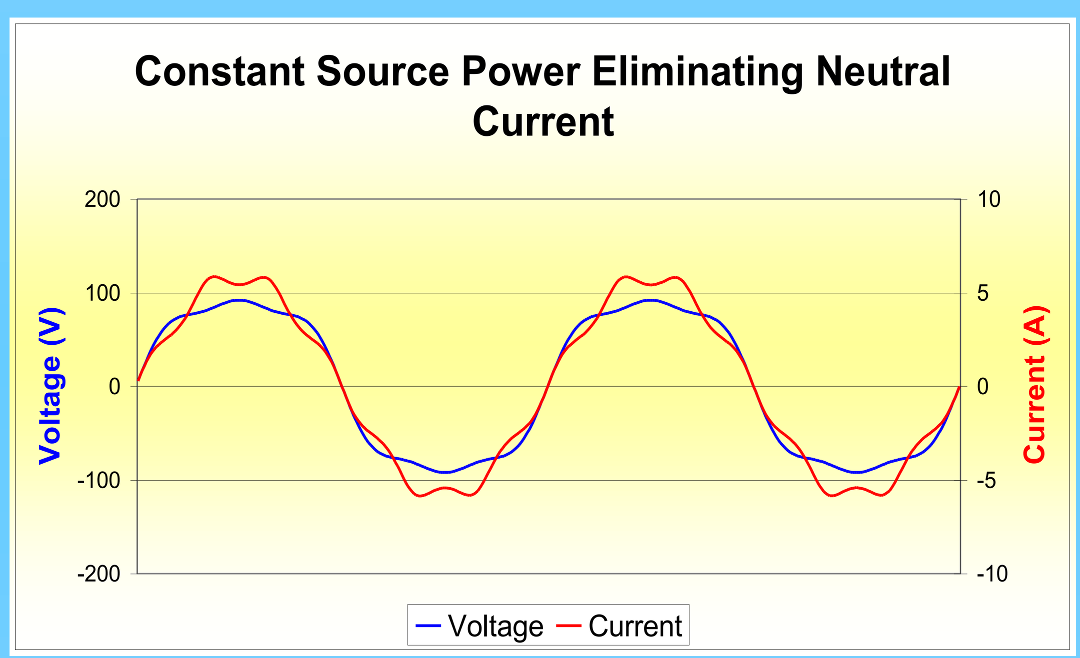
Based on the Original
Instantaneous Reactive Power
Theory

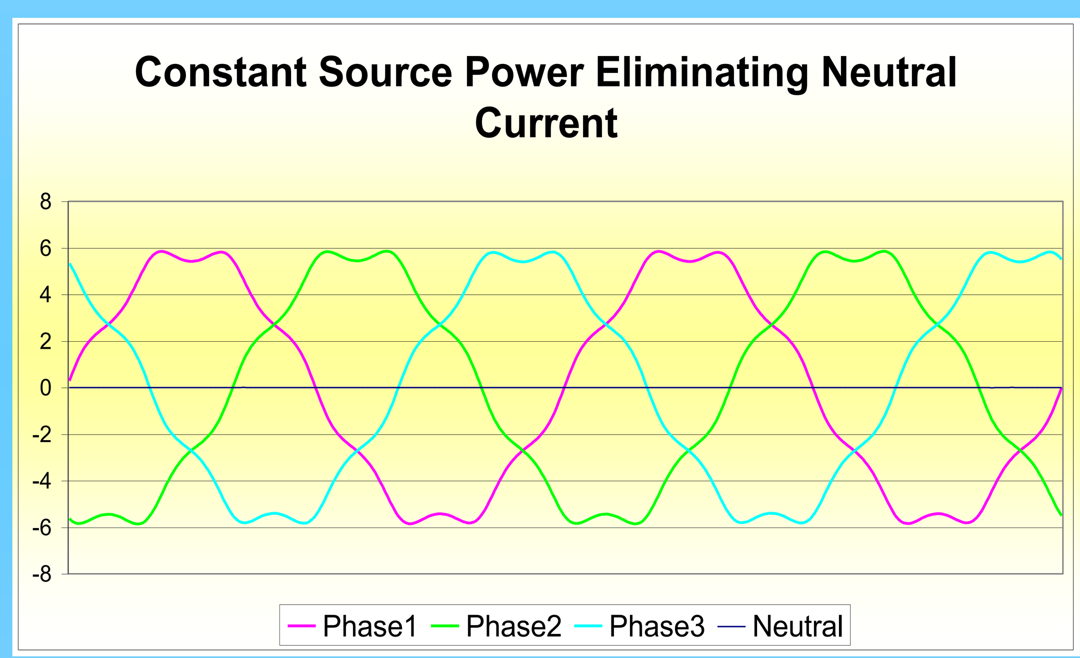
COMPENSATION OBJECTIVE

$$\begin{bmatrix} i_{c0} \\ i_{c\alpha} \\ i_{c\beta} \end{bmatrix} = \frac{1}{e_0 e_{\alpha\beta}^2} \begin{bmatrix} e_{\alpha\beta}^2 & 0 & 0 \\ 0 & e_0 e_\alpha & -e_0 e_\beta \\ 0 & e_0 e_\beta & e_0 e_\alpha \end{bmatrix} \begin{bmatrix} p_{L0}(t) \\ \tilde{p}_{L\alpha\beta}(t) - P_{L0} \\ q_{L\alpha\beta}(t) \end{bmatrix}$$

CONSTANT INSTANTANEOUS POWER

The original conception

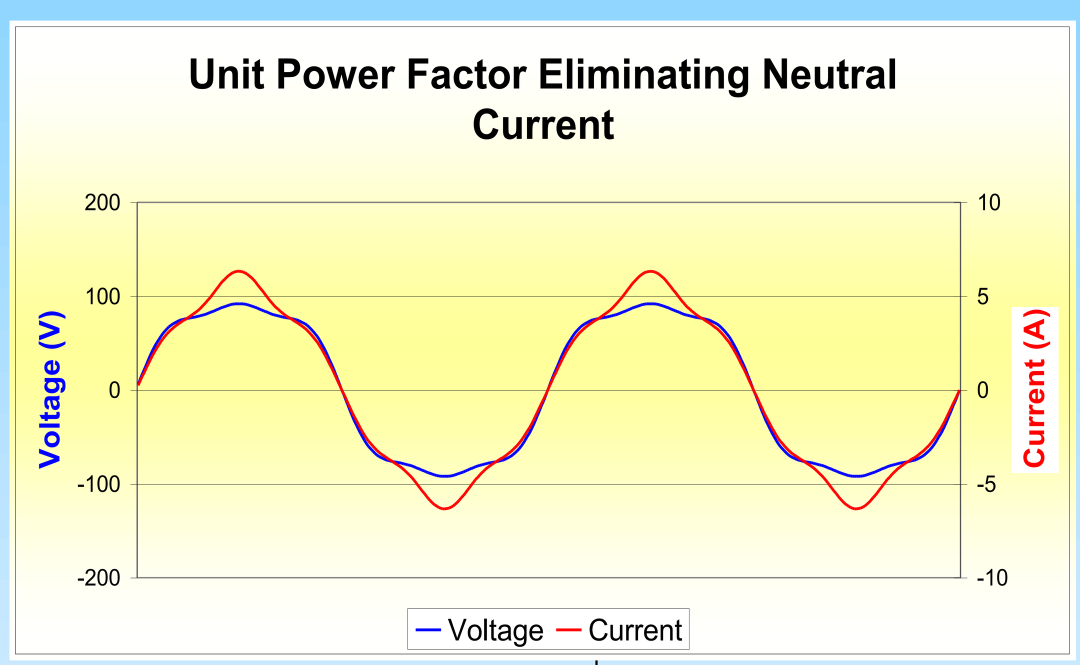


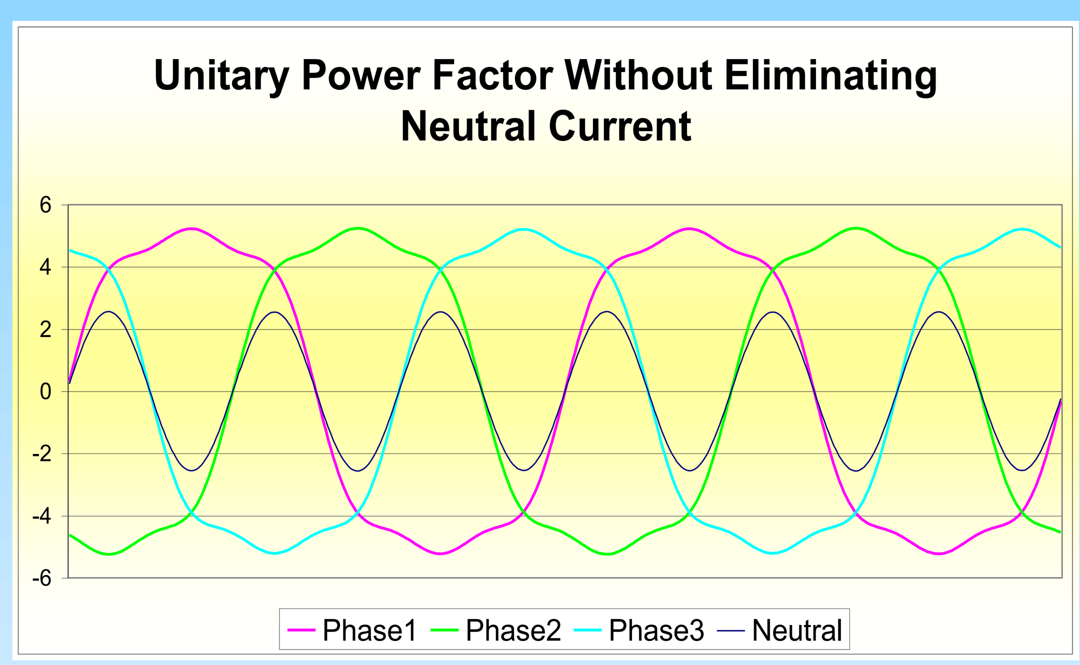


$$\begin{bmatrix} i_{c0} \\ i_{c\alpha} \\ i_{c\beta} \end{bmatrix} = \frac{1}{e_0 e_{\alpha\beta}^2} \begin{bmatrix} e_{\alpha\beta}^2 & 0 & 0 \\ 0 & e_0 e_\alpha & -e_0 e_\beta \\ 0 & e_0 e_\beta & e_0 e_\alpha \end{bmatrix} \begin{bmatrix} p_{L0}(t) - \frac{P_{Lu}}{U^2} e_0^2 \\ p_{L\alpha\beta}(t) - \frac{P_{Lu}}{U^2} e_{\alpha\beta}^2 \\ q_{L\alpha\beta}(t) \end{bmatrix}$$

UNIT POWER FACTOR

With some modifications to the original conception

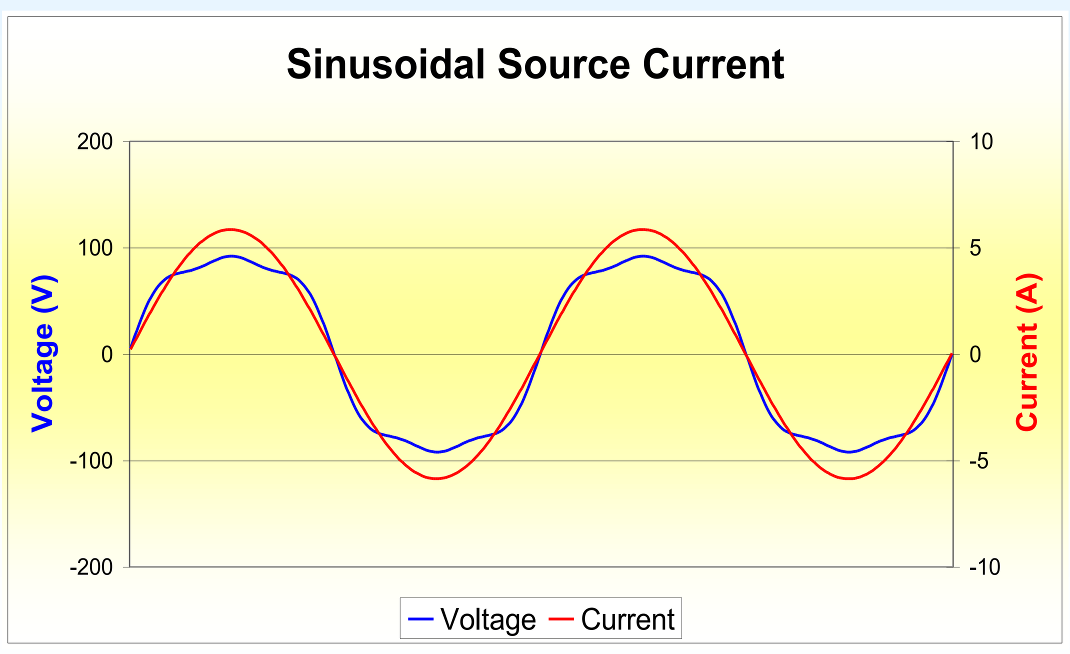


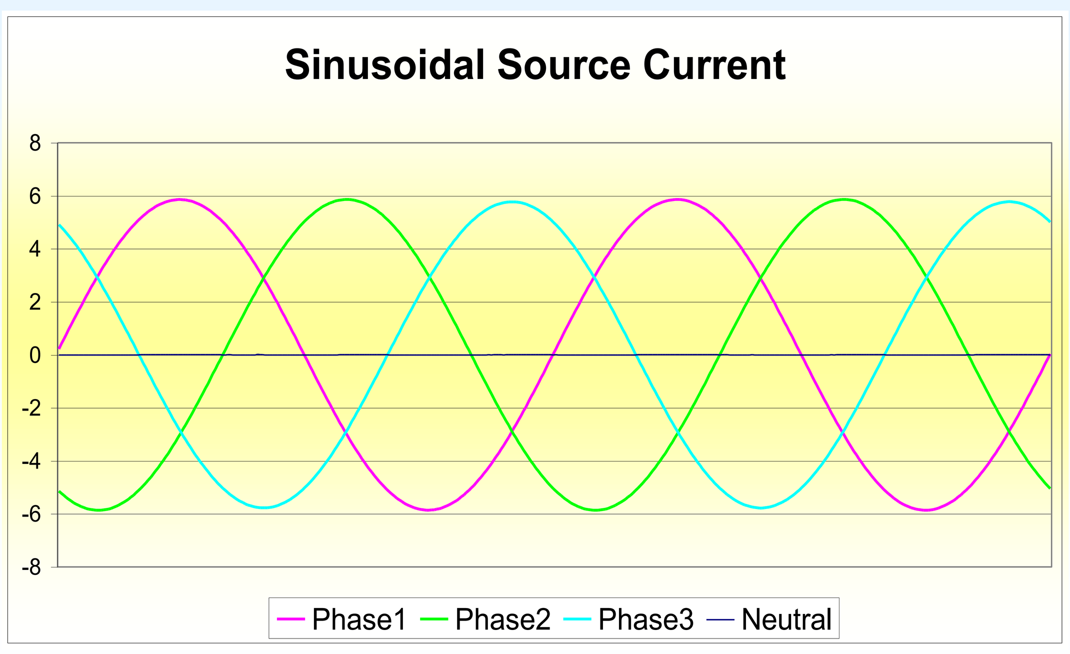


$$\begin{bmatrix} i_{c0} \\ i_{c\alpha} \\ i_{c\beta} \end{bmatrix} = \frac{1}{e_0 e_{\alpha\beta}^2} \begin{bmatrix} e_{\alpha\beta}^2 & 0 & 0 \\ 0 & e_0 e_\alpha & -e_0 e_\beta \\ 0 & e_0 e_\beta & e_0 e_\alpha \end{bmatrix} \begin{bmatrix} p_{L0}(t) \\ p_{L\alpha\beta}(t) - \frac{P_{Lu}}{U_1^{+2}}\left(e_\alpha e_{\alpha 1}^+ + e_\beta e_{\beta 1}^+\right) \\ q_{L\alpha\beta}(t) - \frac{P_{Lu}}{U_1^{+2}}\left(e_\alpha e_{\beta 1}^+ + e_\beta e_{\alpha 1}^+\right) \end{bmatrix}$$

SINUSOIDAL SOURCE CURRENT

With some modifications to the original conception





CONCLUSIONS

It has been presented in this paper an exhaustive analysis of the p-q instantaneous reactive power theory. Besides, it has been carried out a new analysis where it is shown that, with few modifications in the control strategy developed by the authors of the original theory, it may be achieve any compensation target imposed to the system. The results are corroborated by the correspondent simulations in the Matlab-Simulink environment.

References

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