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Three Phase Reactive Power Control Using LabVIEW

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Abstract: The three phase supply is given to load through potential transformers and current sensors. The voltage across the phases is measured and simultaneously current through the circuit is measured to know the power flows in the line. The reactive power is very important and its measurement is used to control voltage and to maintain the quality of power to the utility. In case of variations in reactive power, a huge loss may occur in the system and utility may be penalized heavily. In this aspect, a control mechanism is to be developed to monitor the reactive power and hence voltage in the system. In this paper, a prototype model is proposed to measure the reactive power in the power system. The model is designed to study the corrective measures to compensate the energy losses. This will help in actual design, forecasting and future expansion of the power system. With the powerful LabVIEW system design environment, the hardware and simulation is built to measurement and/or control system in dramatically less time.

Key words: p-q theory, myRIO, LabVIEW

INTRODUCTION

In [1] proposed a new theory for the control of active and reactive power in three phase power systems. The presence of harmonics in the power lines gives power losses in the distribution as well as interference problems in communication systems. Sometimes, the operation failures of electronic equipments usually sensitive in nature that include microelectronic control systems, which work with very low energy levels. Because of these problems, the issue of the quality of power delivered to the end consumers is to given a great concern. Meanwhile, it is mandatory to solve the harmonic problems caused in the system.

Active and Reactive Power Theory (p-q theory)

The p-q theory consists of Clarke's algebraic transformation of the three-phase voltages and currents. The p-q theory is based on the dynamic domain thus it is valid both for steady-state and transient operation of the circuit. It is an interesting tool to apply to the control of active power and reactive power in electrical systems. It allows generic voltage-current waveforms and also control of the active filters in real-time. It is possible to exploit the symmetries of the instantaneous power waveform for each specific power system, achieving a calculation for a delay that is as small as 1/6th of the cycle and not exceeding 1 cycle of the power system frequency. The calculations for reactive power and zero-sequence compensation have no delays.

$p = v\alpha \cdot i\alpha + v\beta \cdot i\beta = p + \sim p$ (1)

p − Mean value of the instantaneous real power. It corresponds to the energy per time unity that is transferred from the power source to the load, in a balanced way, through the a-b-c coordinates (it is, indeed, the only desired power component to be supplied by the power source).

p ~ − Alternating value of the instantaneous real power. It is the energy per time unity that is exchanged between the power source and the load, through the a-b-c coordinates. Since p ~ does not involve any energy transference from the power source to load, it must be compensated.

$q = v\beta \cdot i\alpha - v\alpha \cdot i\beta = q + q\sim$ (2)

q − Mean value of instantaneous imaginary power.

q~ − Alternating value of instantaneous imaginary power.

The instantaneous imaginary power, q, has to do with power (and corresponding undesirable currents) that is exchanged between the system phases, and which does not imply any transference or exchange of energy between the power source and the load. Rewriting equation (1) in a-b-c coordinates the following expression is obtained. This is a well-known expression used in conventional reactive power meters, in power systems without harmonics and with balanced sinusoidal voltages. These instruments, of the electro dynamic type, display the mean value of equation (2). The instantaneous imaginary power differs from the conventional reactive power, because in the first case all the harmonics in voltage and current are considered. In the special case of a balanced sinusoidal voltage supply and a balanced load, with or without harmonics, q is equal to the conventional reactive power.

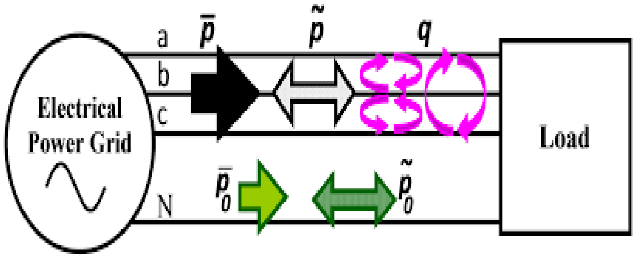


Figure 1. p - q theory power flow directions in the system

LabVIEW Architecture and Functions

LabVIEW programs are called virtual instruments, or VIs, because their appearance and operation often imitate physical instruments, such as oscilloscopes and multi meters. LabVIEW contains a comprehensive set of tools for acquiring, analyzing, displaying, and storing data, as well as tools to help you troubleshoot the code you write. Unlike general-purpose tools, LabVIEW tightly integrates any hardware with extensive analysis and signal processing libraries, offers custom graphical user interfaces, and allows you to deploy these systems to a platform that uses the newest and most advanced technology. LabVIEW software the multiplication of a measured voltage and the measured current is obtained. The voltage and current are given as inputs to the data acquisition card from it. The output n digital form is obtained which is given to the comparators for control purpose. So the power factor can be maintained with a desired value. The software of the LabVIEW instrument will decide how many capacitor banks to be used. The binary weights are used for this principle.

Description of LabVIEW blocks

A) Simulate signal

Signal type—Type of waveform to simulate. A sine wave, square wave, saw tooth wave, triangle wave or noise (DC) can be simulated.

Frequency (Hz): Frequency in hertz of the waveform.

Phase (deg.): Initial phase in degrees of the waveform.

Amplitude: Amplitude of the waveform.

B) Multiplier

It generates parallel and constant coefficient multipliers. The use of dedicated hardware multipliers, slice logic, or a combination of resources is specified.

C) Adder / Subtractor

It creates adders, subtracters, and adders / subtracters that operate on signed or unsigned data. In fabric, the module supports inputs ranging from 1 to 256 bits wide, and outputs ranging from 1 to 258 bits wide.

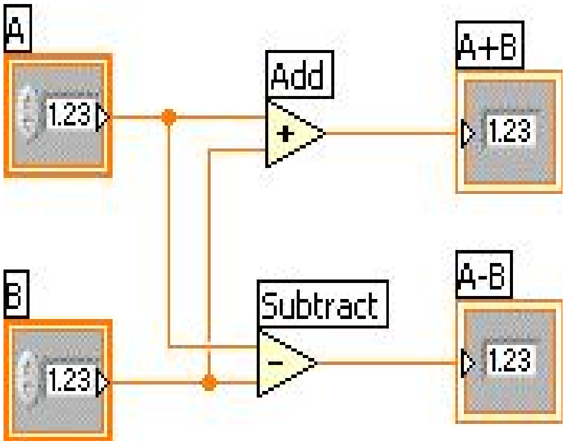
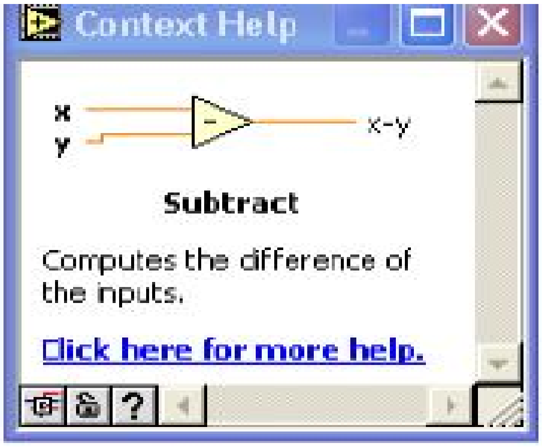


Figure 2. Adder / Subtractor



Subtract

Computes the difference of the inputs.

Click here for more help.

Fig.3 Snapshot of Simulation of Adder / subtractor

D) Waveform chart

Displays numeric data contained in arrays and analog waveforms. Analog waveform data acquired at a constant rate with a history, or buffer, of the data from previous updates.

myRIO:

myRIO connects the LabVIEW and personal computer. Here, the circuit mainly consists of a 3 phase supply connected to a 3 phase inductive load. To measure the voltage and current at each phase the potential and current sensors are connected. The current sensor is given in series to the load and potential power of the three phases is given to adder thus obtaining the total power in the circuit. The voltage difference between the two successive phases is calculated by the substracters. And their outputs are multiplied with the phase currents of the other phase. By using two adders the outputs of these three multipliers are added and the graph is plotted using LabVIEW.

Figure 4. Snapshot of myRIO

Reactive power LabVIEW simulation:

Output Waveforms of three phase power:

The estimated results of three phase reactive power measurement using LabVIEW are displayed below.

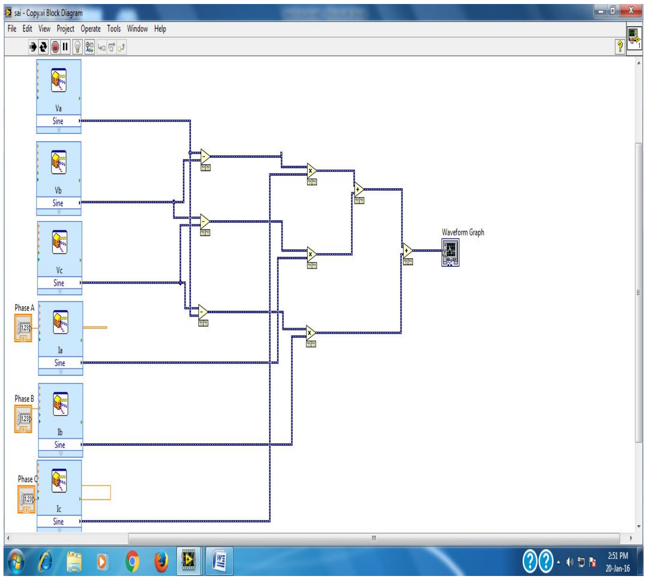
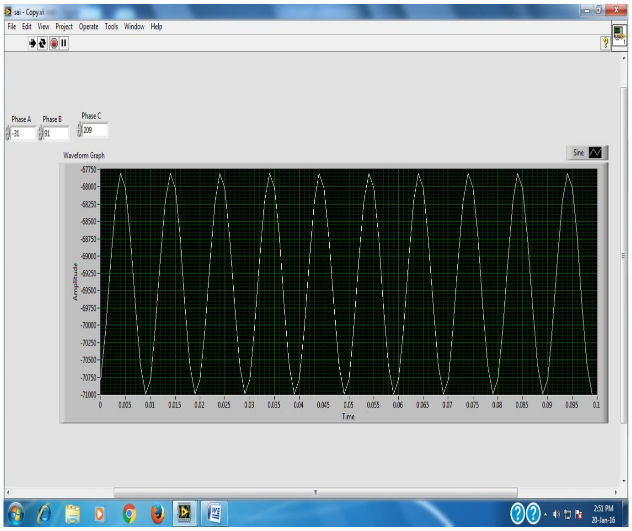


Figure. 5 block diagram of reactive power in labVIEW



Phase A -31
Phase B 91
Phase C 209

Figure6. Waveform of reactive power in labVIEW

Active power LabVIEW simulation

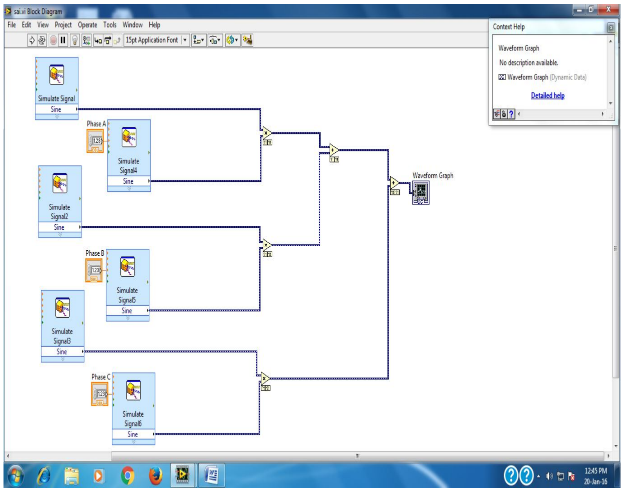
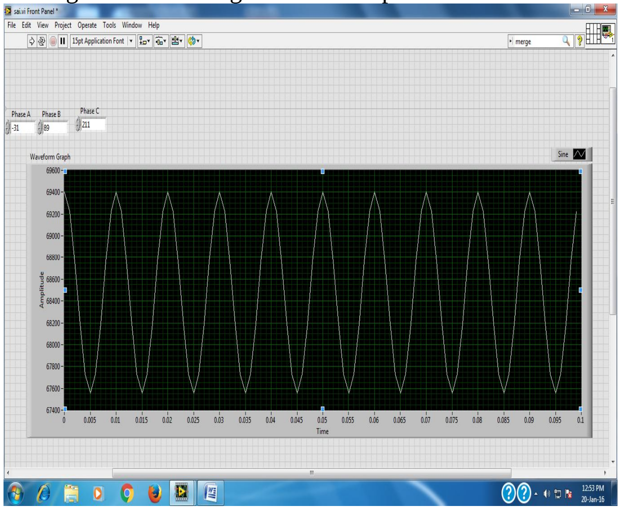


Figure.7 block diagram of active power in labVIEW



Phase A -31
Phase B 89
Phase C 211

Figure 8. Waveform of active power in labVIEW front panel

Conclusions

The paper briefly describes the calculations and physical meaning of the p-q theory power components. In three-phase electrical systems the instantaneous real power presents symmetries of 1/6, 1/3, 1/2 or 1 cycle of the power system fundamental frequency, depending on the system being balanced or not, and having or not even harmonics. The three phase reactive power is measured by using myRIO device, which is interfaced with LabVIEW and in turn it is controlled by capacitor banks. The energy wastage is reduced by using the controlling technique. Experimental results prove the good dynamic response of the reactive power controller based on the p-q theory.

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References

[1]. H. Akagi, Y. Kanazawa, A. Nabae, Generalized Theory of the Instantaneous Reactive Power in Three-Phase Circuits, IPEC'83 - Int. Power Electronics Conf., Tokyo, Japan, 1983, pp. 1375-1386.
[2]. H. Akagi, Y. Kanazawa, A. Nabae, Instanataneous Reactive Power Compensator Comprising Switching Devices without Energy Storage Compenents", IEEE Trans. Industry Applic., vol. 20, May/June 1984.
[3]. Quin, C., Mohan, N., Active Filtering of Harmonic Currents in Three-phase Four-Wire Systems with Three-Phase and Single-Phase Non-Linear Loads, APEC, 1992, pp. 829-836.
[4]. M. Aredes, E. H. Watanabe, "New Control Algorithms for Series and Shunt Three-Phase Four-Wire Active Power Filters", IEEE Trans. Power Delivery, vol 10, no. 3, July 1995, pp. 1649-1656.
[5]. E. Clarke, Circuit Analysis of A-C Power Systems, Vol I – Symetrical and Related Componentes, John Wiley and Sons, 1943.
[6]. C. L. Fortescue, "Method of Symetrical Co-ordinates Applied to the Solution of Polyphase Networks", A.I.E.E. Trans., vol. 37, June 1918, pp. 1027-1140.