Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 86 (2016) 112 – 115

Procedia Computer Science

2016 International Electrical Engineering Congress, iEECON2016, 2-4 March 2016, Chiang Mai, Thailand

GIFL Gain choosing technique for fast voltage sag/swell detection

Mongkol Danbumrungtrakul [a*], Trin Saengsuwan [a] and Phinit Srithorn,[b]

[a] *Department of Electrical Engineering, Faculty of Engineering,Kasetsart University, Bangkok 10900, Thailand.*
[b] *Department of Electrical Engineering, Faculty of Engineering and Architecture, Rajamangala University of Technology Isan, Nakhon Ratchasima 30000, Thailand.*

Abstract

This paper presents a technique to improve the response of single-phase voltage sag/swell detection using generalized Integrator with a feedback loop (GIFL). The GIFL provides an orthogonal signal required for evaluating the instantaneous voltage magnitude. For the GIFL, constant gain K is the key influencing its overall performance. Then, the main objective of this paper is to introduce a method for choosing the best GIFL's constant gain; speed and overshoot of the GIFL are considered with varying gain K. Both simulation and experiment were carried out in order to confirm the idea proposed in this paper; the experimental results match the simulations as expected. This technique could find its application in order to enhance the performance of FACTS devices used in single-phase power systems, especially for precise power compensation during fast transients.

Keywords: voltage sag/swell, peak detection, phase shifting, GIFL, gain choosing.

1. Introduction

In power systems, voltage sag and swell have been mentioned recently as one of power quality problems. Although the change of voltage magnitude will last only around 30 cycles, all sensitive loads may work abnormally or be malfunctioned; some may be stopped if its protection systems see the obvious of the magnitude change [1]. Most of the researchers propose that the best way to deal with this problem is to mitigate the sag and swell of voltage, rather than to avoid the causes of this kind of power quality problems. Power compensation using flexible AC transmission system (FACTS) devices has been introduced for mitigating voltage sag and swell, and has been the most popular [2-4]. However, performance of the compensation relies heavily on how fast the FACTS devices can detect the voltage variation.

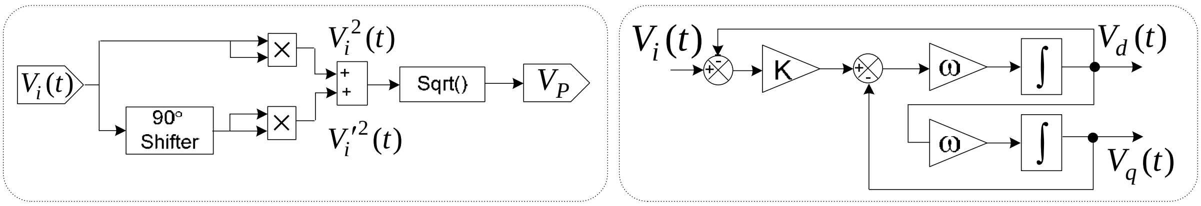
doi:10.1016/j.procs.2016.05.028

Instantly detecting the change of voltage magnitude when transients occur may be done in four different ways as described in [5]; hysteresis voltage control, RMS value evaluation, missing voltage technique, and peak voltage evaluation technique. And, the researchers in [5] have also summarised that the peak voltage evaluation is the fastest method to detect voltage magnitude change. The peak voltage detection is therefore the most common method amongst researchers, although a new evaluation is proposed in [6]; but with more complicate and additional delay time. Therefore, enhancement of the peak voltage evaluation technique should be one of the ways to add superior performance to the single-phase FACTS devices.

In single-phase power systems, to performing peak voltage detection will need a 90^o displacement signal to the originally monitoring voltage. Speed of the process of generating this orthogonal signal is then the key to enhance the peak voltage detection performance. Therefore, this paper will focus on this process to make the most of peak voltage measurement. Setting the best constant gain in the GIFL, MatLab m-file is linked to SimPowerSys model in order to vary the gain and generating the associating graphs. Compromising between the GIFL's response time and the resulting overshoot is the key to choose the best constant gain.

2. Peak Voltage Detection

In single-phase power systems, instant voltage magnitude calculation using the peak detection principle requires that the monitored input voltage signal (Vi) and its 90^o shifted signal (Vi') will be processed as the diagram shown in Fig. 1(a); the generalized integrator with a feedback loop (GIFL) provides the orthogonal signal for the calculation, and then results in the instant voltage magnitude. Response of this evaluation is therefore depended on the 90^o phase shifter or the GIFL detailed as illustrated in Fig. 1(b), where a constant gain K influences both d and q axis voltage (Vd and Vq). Therefore, choosing the best gain K will result in the best response of the system.



(a) (b)

Fig. 1. (a) Peak voltage detection process (b) The GIFL

3. The proposed technique for choosing the best GIFL's gain K

As mentioned above, varying gain K will influence the GIFL performance and the associated voltage magnitude detection. To enhance the GIFL performance is therefore to choose the best constant gain K. The idea proposed here is to automate the associated plots using MatLab m-file linked to SimPowerSys models. Then, detecting speeds and output overshoots when varies gain K will be generated as shown in Fig. 2. Focusing on different instant voltage, point on the wave (POW) when the change occurs and percentage of the output overshoot (%OS) are illustrated in Fig. 2(a) and (b) respectively :- (reference system is mentioned in verification section).

Traces illustrated in Fig. 2(a) show that the fastest detection is when the GIFL responds to a sudden change of voltage at 90^o POW (peak). The trace of POW at 90^o also shows the higher K will result in the faster response. However, not all the higher K would guarantee the GIFL will work at the best performance; it is limited by the overshoot added to the output signal when higher K is used in. This limitation due to the overshoot is clearly plotted in Fig. 2(b).

From these two plots, if we want to limit the overshoot not to exceed 10%, the best gain K is at 2.9. And for this technique, the influence of both POW and overshoots of the output have been summarized for convenient use in the future as shown in Fig. 3(a) and (b) respectively; waveforms show the POW at 90^o will give the fastest detection (0.25ms when 0.5pu voltage sag occurs), and the POW at 0^o will result in the highest overshoot.