"A Microcontroller Based Voltage Balancing for System Stability"

Varsharani Sopan Kolase[1] Sarika Balaso Patil[2] Geetanjali Laxman Salgoankar[3]
[1,2,3]Department of Electrical Engineering
[1,2,3]SKN Sinhgad Institute of Technology and Science, Lonavala, India

Abstract— The system proposed in this paper voltage balancing to load is done by using PIC microcontroller and trigger required capacitors and inductor bank to compensate reactive power and bring power within the permissible limit. Most of the commercial and industrial installation in the country has large electrical loads which are severally inductive in nature causing lagging power factor. The system voltage deviation is detected by PIC microcontroller and switching ON the respective bank.

Key words: PIC Microcontroller 18F458, Inductor bank, Capacitor bank, relay, LCD display

I. INTRODUCTION

As the demand for electric power grows the energy efficiency term is very significant. Electric load consuming alternating currents consume both active power and reactive power. The active power does useful work and reactive power dissipates no energy in the load and return to the source on current cycle. When the inductive loads are connected to the power system network, the voltage at the consumer side reduces due to high reactive power requirement. This is due to the increased load current caused by increased reactive power consumption due to the lagging power factor of the inductive load. This will increase the system losses and hence reduces the efficiency. The aim of this project is to find a good solution to voltage unbalancing, through a sustainable development of automatic system that corrects low power factor. To achieve this Microcontroller with the Mosfet circuit is efficiently used.

II. LITERATURE SURVEY

A. Micro-Controller-Based Voltage Balancer in an Electrical Distribution System:

In power system operation, balanced three-phase transmission and distribution systems are normally assumed to be balanced. However, unbalanced load currents resulting from unbalanced loads are usually encountered in distribution systems. A great number of a single load and three-phase Y-connected loads are connected to radial distribution feeders. Both industry and domestic equipment are sensitive to voltage changes above or below a given magnitude. Too high voltage may lead to insulation failure, damage to components or mal-operation of electrical equipments, too low voltage results in unsatisfactory performance; and both can easily affect the grid [2].

B. Report On the Grid Disturbance On 30th July 2012 And Grid Disturbance On 31st July 2012:

A disturbance occurred in the Northern India electricity grid at 0233 hours of 30th July 2012leading to a blackout in nearly the entire Northern region covering all the 8 States The frequency just before the incident was 49.68 Hz. The All India Demand Met prior to the incident was about99700 MW and the demand being met in the Northern Region was about 38000 MW.[3].

C. Study of Different Methods for Enhancing Power Quality Problems:

Due to the increasing use of loads sensitive to power quality, e.g. Communications and medical equipment, variable speed drives, rectifiers, Uninterruptible Power Supplies(UPS), Personal computers (PC), Television (TV) sets etc. the issue of power quality has gained renewed interest over the last two decades. Nowadays, voltage balancing is an even more complex problem than in the past because the new loads are not only sensitive to power quality but also responsible for affecting adversely the quality of power supply. Some types of the power quality problems are voltage sag/swell, interruption, voltage fluctuation, voltage unbalance, current unbalance. Among them, voltage sags/swells and current harmonics are the most common power quality problems [4].

III. MATHEMATICAL DERIVATION

In the system Var demand is keep on varying which is need to satisfy by reactive power compensation to achieve power factor correction. Generally when load on the system increases that is Var demand increases system faces the voltage sag. To maintain desired voltage profile that is flat voltage per unit, the VARs demand of the load must be met locally by employing positive Var generators.

Accurate Deviation ΔV = | IR | R cosØ + | IR | X sinØ
= [| VR | | IR | R cosØ + | VR | | IR| sinØ] ÷ | VR |
= [R PR + X QR] ÷ | VR |

A. Method of Voltage Control:

All the equipments in the power system are rated for a certain voltage with a permissible band of voltage variations.

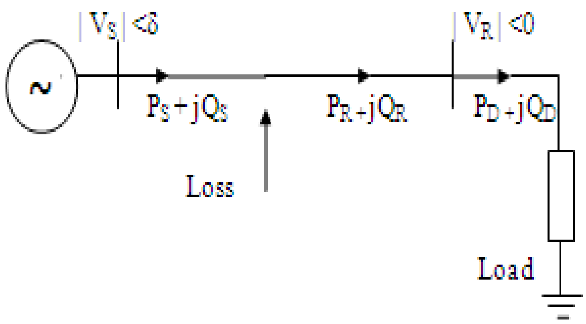

Fig. 1: General diagram of power system

The equations for active and reactive power can be given as

$$P_R = \frac{|V_S|\,|V_R^S|}{x}$$

$$Q_R^S = |V_R^S|\,(\,|V_S|\,|V_R^S|\,)$$

$$|V_R^S| = \frac{1}{2}\,|V_S| + |V_S|\,[\,(1 - 4{*}Q_R^S)\,/\,|V_R|^2\,]^{1/2}$$

$$P_R = P_D$$

In the system QR must remain fixed at QRS for fixed |VS| and specified |VRS| that is any one value of QD.

QD = QDS

For Practical loads:
Generally loads are inductive in nature.
Hence, Var demand $Q_D > Q_R^S$
Hence, $V_R \neq V_R^S$ to meet demands.
Now VAR_S,

$$\text{Hence, } Q_D = Q_R = \frac{|V_R| (|V_S| - |V_R|)}{X} \text{ For } Q_D > Q_R^S$$

Modified $|V_R|$

$$|V_R| = \frac{1}{2} |V_S| + |V_S| [(1 - 4*Q_R^S) / |V_R|^2]^{1/2}$$

For

$$Q_D = Q_R > Q_R^S$$
$$|V_R| < |V_R^S|$$
$$\text{Hence, } Q_R > Q_R^S$$
$$|V_R| > |V_R^S|$$

It is the need of the system to regulate the line voltage under varying VAR_S demands. To achieve this there are some methodologies as given bellow:

1) Reactive power injection
2) Synchronous condenser

If V_R^S within band then Q_R^S will also remain in band.

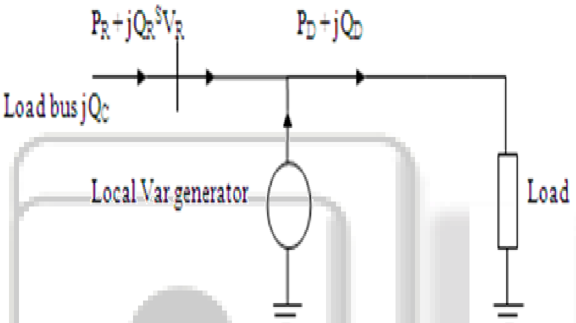

Fig. 2: Use of local Var generator at the load bus compensating equipment

B. Var Balance Equation:

$Q_R^S = |Q_C = Q_D$
Here Q_R^S remain fixed hence V_R^S assumed to be fixed.
$I_C - j |V_R| / \sqrt{3} X_C$ kA

$$jQ_C (3\text{-}\emptyset) = \frac{3 | V_R |}{\sqrt{3}} (- I_C^*)$$
$$= \frac{j3 | V_R |}{\sqrt{3}} \times \frac{| V_R |}{\sqrt{3}} \quad \text{MVA}$$

$$Q_C (3\emptyset) = \frac{| V_R |^2}{X_C} \quad \text{MVAR}$$

For inductors, VAR_S fed into line

$$Q_L (3\text{-} \emptyset) = - \frac{|V_R|^2}{X_L} \quad \text{MVAR}$$

Hence, For heavy load conditions positive Var required, for providing it capacitor bank can be used and for light load conditions negative Var required, for proving it inductor bank can be used.

IV. Operation of System

Fig. 3: circuit implementation

In conventional system now we are using the common capacitor –inductor bank for all the loads connected in system for balancing the voltage to a set point. In our project we are presenting new technique which constitute distributed inductor-capacitor bank for each load which gives the specific controlling with respect to the set point and according to the load requirement. In this technique we are controlling the switching action of relay circuit with the help of microcontroller.

Load is consuming alternating current it consume both active and reactive power. The active power does useful work and reactive power gives no useful work. When the inductive are connected to the power system network, voltage at the consumer side reduce due to high reactive power requirement. This is because of increased load current which is caused by increase in reactive power consumption. Inductive load use lagging power factor. This will increase the system losses and reduce efficiency.

In this system when the load voltage is reduced. This voltage gives as the input to microcontroller, but microcontroller are operated on digital signal. In microcontroller inbuilt analog to digital converter are present. This ADC converts analog signal into digital signal. In microcontroller in built comparator is present. It compares the set voltage and load voltage. When v load is less than v set point then microcontroller gives the signal to relay, then relay switches capacitor bank. When capacitor bank is on it supplies the reactive power which causes increase in voltage. Similarly the exact opposite action will take place in the case of capacitive loads and inductor bank switches to consume the voltage. Hence we get the required balanced voltage.

In the continuous operation of the system the LCD will continuously changing value of the voltage. When the system voltage is balanced the LCD will show the value of the voltage. When voltage is balanced automatically power factor get corrected

V. Conclusion

In this project we have focused on the main objective that is voltage balancing to achieve power factor correction through reactive power compensation. As in practice reactive power cannot be transmitted over a long distance or through power transformer due to excessive reactive power losses, therefore it is needed to be supplied in close proximity to its consumption or load side.

ACKNOWLEDGMENT

We would like to express our gratitude to Prof. Satya Prakash for necessary support and guidance during various stages of work. I would also like to thank our management for support.

REFERENCES

[1] Voltage Support by Distributed Static VAr Systems (SVS) by SlavenKincic (Student Member, IEEE, XiaotongGrace), T. Wan, Donald T. Mc Gillis, and Ambrish Chandra published in IEEE transactions on power delivery, vol. 20, no. 2, April 2005.
[2] A microcontroller based voltage balancer in a distributed electrical system by A. Bensaadi Department of Electrical Engineering, Batna, Algeria, February 2002.
[3] Report on grid disturbance of 30th July 2012 and grid disturbance on 31st July 2012Submitted in Compliance to CERC, 1st Aug2012.
[4] Study of Different Methods for Enhancing Power Quality Problems by Priyanka Chhabraa, Electrical Eng. Dept.(MMEC), MM University, Mullana, India.
[5] Power System Control with distributed flexible AC transmission system devices by Katherine Margaret Rogers B.S., University of Texas, 2007.
[6] IEEE transactions on power electronics, vol. 22, no. 6, November 2007 2253 distributed facts, a new concept for realizing grid power flow control Deepak Divan and Harjeet Johal.
[7] Standard book of PIC microcontroller and embedded systems by Muhammad Ali Mazidi, Rolind D. Makinlay, Danny Causely, 4th edition 2011, published by Dorling Kindersley(India) pvt. ltd.
[8] Standard book of Modern Power System by D. P. Kothari, I. J. Nagrath, 4th edition, McGraw Hill education(India) pvt. Ltd., New Delhi.