

Lab VIEW based Simple Load Flow Calculator Model for Three Phase Power System Network

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ABSTRACT

The main Objective of this research work is to develop a simple load flow calculator in LabVIEW for three phase power system Network. LabVIEW based load flow calculator has been chosen as the main platform because it is a user friendly and easy to apply in Power Systems. This research work is designed to concurrently familiarize the power system engineers with the use of LabVIEW with electrical power systems. This proposed work will discuss design and development of the interactive instructional virtual instrument (VI) modules in power systems load flow solutions. In the proposed model load flow has been carried out based on Gauss-Seidel method and model has been developed such that it can accommodate latest versions of load flow algorithm.

Keywords

Load flow analysis, Gauss-Seidel method, LabVIEW, Three phase power system network

1. INTRODUCTION

In light of the late advances in PCs and advances, the multifaceted nature in every aspect of the electrical power industry (era, transmission, distribution, control, and so on.) has expanded and the graduates of engineering must be well-trained to address the needs of the industry. To address this need, the greater part of the engineering programs and a percentage of the designing innovation programs have presented courses, programs, and research facilities in power systems to give the graduates the hypothetical and down to earth information, and additionally encounter. The investigation of electrical power systems requires a decent foundation on cutting edge science, and since a large portion of the engineering innovation programs don't require propelled arithmetic, it is hard to show electrical power systems in these programs.

To deal this subject, numerous content driven software programs are as of now utilized as a part of college to outline and break down diverse systems. A decent illustration of

such programs is MATLAB software. With the coming of object-oriented software, now programs that are intelligent and easy to use. Utilizing such PC programs permits understudies to invest less energy written work the code to take care of an issue and invest additional time comprehension the ideas. LabVIEW software is a graphical software environment and depends on the idea of data flow software. Initially intended for test and estimation applications, the system has been altered in the course of the most recent 15 years to plan and break down different complex systems.

It is generally acknowledged by industry, college, and examination research centers far and wide as a standard for

data acquisition (DAQ) and instrument control software [1]. Users of LabVIEW can construct instrumentation called virtual instruments (VIs) utilizing software items. With legitimate equipment, these VIs can be utilized for remote data acquisition, analysis, design, and distributed control.

The built-in library of LabVIEW has various VIs that can be utilized to plan and add to any system. LabVIEW can be utilized to address the needs of different courses in a technology and science program [2] [3]. The objective of this paper is to discuss the application of built-in VIs in LabVIEW to develop VI modules for use in electrical power systems load flow solutions.

2. APPLICATION OF LABVIEW IN ELECTRICAL ENGINEERING[4]

LabVIEW is to a great degree adaptable and a portion of the application zones of LabVIEW are Simulation, Data Acquisition, and Data Processing. The Data Processing library incorporates signal generation, digital signal processing (DSP), measurement, filters, windows, curve fitting, probability and statistics, linear algebra, numerical methods, instrument control, program development, control systems, and fuzzy logic [5]. These components of LabVIEW will give an interdisciplinary, integrated teaching and learning experience that incorporates team-oriented, hands-on learning experiences throughout the engineering technology and sciences program, connecting with understudies in the outline and investigation procedure. LabVIEW can order DAQ sheets as appeared in Figure 1 to peruse simple information flags (A/D conversion), produce simple yield signals (D/A conversion), read and compose computerized flags, and control the on-board counters for frequency measurement, pulse generation and so forth. The voltage information goes into the module DAQ board in the computer, which sends information into computer memory for storage, processing, or other manipulation. [6]

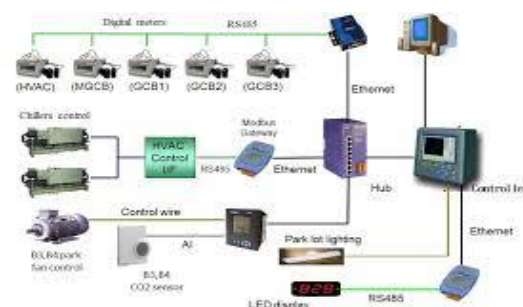


Figure 1 LabVIEW based data communications network [8]

3. LOAD FLOW ANALYSIS

The load flow analysis studies are vital for planning, economic scheduling control and of existing system and also arranging its future development rely on knowing the impact of interconnections, new loads, new generating stations or new transmission lines, and so forth before they are introduced. The data acquired from load flow studies are the magnitude and phase angle of voltages at each bus, active and reactive power flow in each line, and power loss in the line. It likewise gives the introductory states of the system when the transient behavior of the system is to be studied. The mathematical formulations of the load flow problems are in a system of non-linear equations. These equations can be composed as far as either the bus admittance matrix or bus impedance matrix. Utilizing bus admittance matrix is manageable to advanced computer analysis, because it could be formed and modified for network changes in subsequent cases and requires less computation time and memory. Load flow analysis is performed on a symmetrical steady state operating condition of a power system under normal mode of operation. [7]

The following steps has been performed for a load flow study

- Model the power system network by single line diagram.
- Determination of impedance through y bus matrix
- Formulation of Non –linear power equations
- Solution of network equations will lead to load flow solutions.

Power balance equation

$$P_i = \sum_{i=1}^N P_i = \sum_{i=1}^N PG_i - \sum_{i=1}^N PD_i \quad (1)$$

Here, the investigation is limited to a balanced three phase power system, so that the analysis can be carried out on a single phase basis. The per unit quantities are utilized for all quantities. The initial phase in the analysis is the definition of suitable equations for the power flow in the system. The power system is a huge interconnected system, where different buses are connected by transmission lines. At any bus, complex power is injected into the bus by the generators and complex power is drawn by the load. Obviously at any bus, both of them may not be present. The power is transported from one bus to other by means of the transmission lines. At any bus I, the complex power S_i (injected), appeared in Figure 2 is characterized as

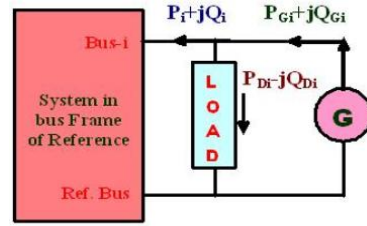


Figure 2 –Power injection model [9]

$$S_i = S_{Gi} - S_{Di} \quad (2)$$

where S_i = net complex power injected into busi, S_{Gi} = complex power injected by the generator at busi, and S_{Di} = complex power drawn by the load at busi. According to conservation of complex power, at any bus i, the complex power injected into the bus must be equal to the sum of complex power flows out of the bus via the transmission lines. Hence,

$$S_i = \sum S_{ij} \quad (3)$$

where S_{ij} is the sum over all lines connected to the bus and n is the number of buses in the system (excluding the ground). The bus current injected at the bus-i is defined as

$$I_i = I_{Gi} - I_{Di} \quad (4)$$

Where I_{Gi} is the current injected by the generator at the bus and I_{Di} is the current drawn by the load (demand) at that bus.

$$I_{BUS} = Y_{BUS} V_{BUS} \quad (5)$$

The Real and Reactive power Equations are

$$P_i = V_i \sum_{j=1}^n Y_{ij} * V_j * \cos(-\theta_{ij} + \delta_i - \delta_j) \quad (6)$$

$$P_i = V_i \sum_{j=1}^n Y_{ij} * V_j * \cos - (\theta_{ij} - \delta_i + \delta_j) \quad (7)$$

$$Q_i = V_i \sum_{j=1}^n Y_{ij} * V_j * \sin - (\theta_{ij} - \delta_i + \delta_j) \quad (8)$$

The Voltage Equation is

$$V_i = \frac{1}{Y_{ii}} \left[\frac{P_i - jQ_i}{V_i} - \sum_{j=1}^n Y_{ij} V_j \right] \quad i = 2, 3, \dots, \dots, \dots, n \quad (9)$$

The solution of load flow gives bus voltages and line /transformer power flows for a given load condition. This information is essential for long term planning and operational planning in power systems operations [10]. This indicates the need for automating the load flow calculations and develop a load flow calculator in a good platform is essential. LabVIEW is a powerful to create a calculator model for load flow analysis.

4. LABVIEW BASED LOAD FLOW CALCULATOR MODEL

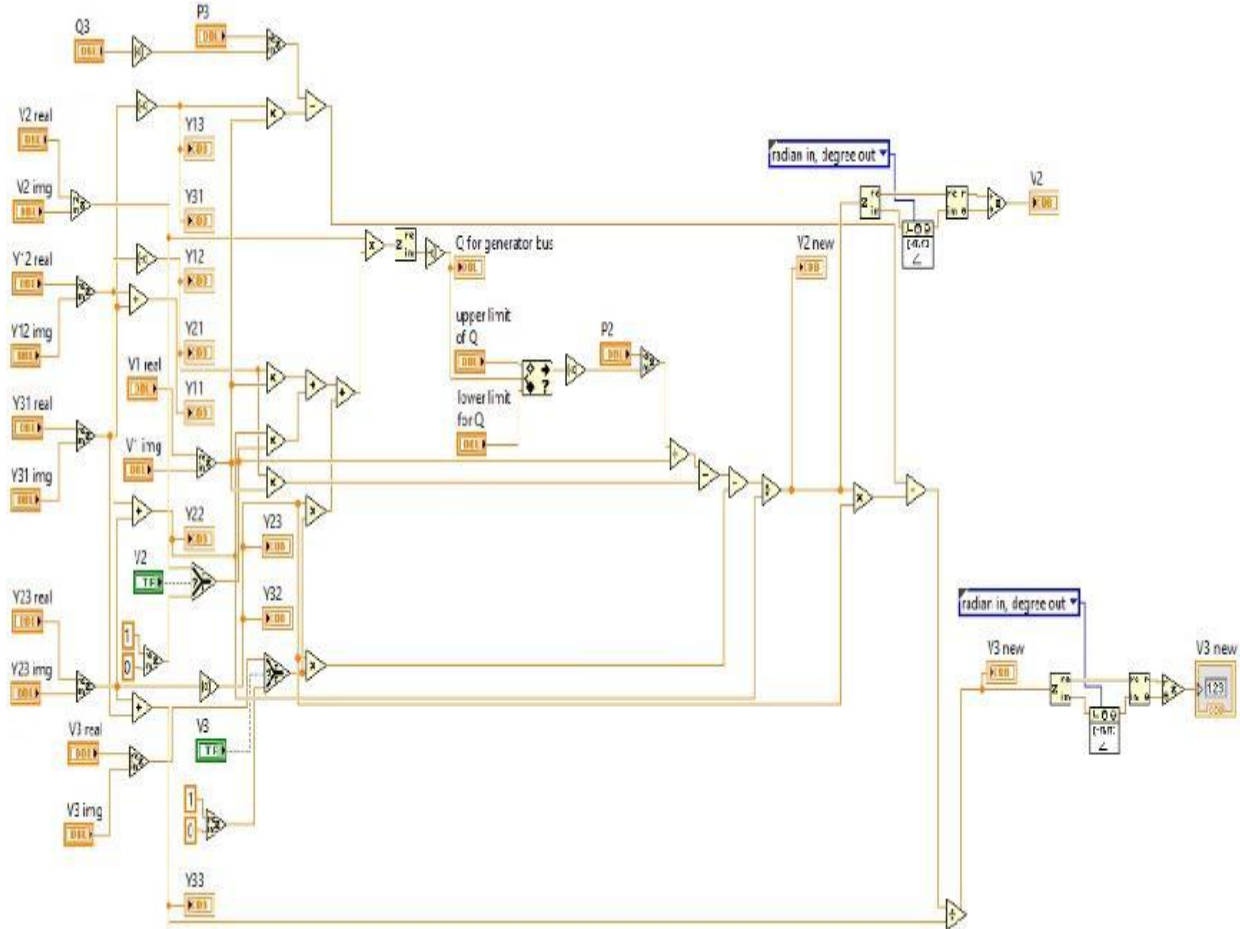


Figure 3 Load flow calculator model

In this proposed LabVIEW based load flow calculator model, initially the bus datas were obtained from the power system network. After collecting the bus datas, the block diagram panel will be used to design the Load flow calculator model as shown in Figure 2. Real and imag admittance values were collected separately and by using Re/Im to Complex tool in LabVIEW the Y bus matrix were formed. Next reactive power need to be calculated for generator bus. For that the admittance value is separated as real and imag part by using Complex to Re/Im tool in LabVIEW. In Range and Coerce tool box will check the Q-limit violation for the Obtained Q value. If the obtained value is Less than Q_{min} , then Q_{min} will be assumed as

Reactive power of generator bus or if the obtained value is greater than Q_{max} , then Q_{max} will be assumed as Reactive power of Generator bus. Select tool is used here to check whether the voltage is available or not in the bus. If it is available, that voltage will be accounted for calculating the next bus voltages. If not, it will assume the voltage value as 1 p.u. To calculate the Voltage and phase angle of the load bus, Re/Im to polar tool is used here. To Display the output of all buses an array is used. This array term is formed by using Bundle tool in LabVIEW. Both input and output will be displayed in the Front panel of LabVIEW as shown in Figure 3.

4.1 Step by step developmental procedure for load flow calculator

Implementation of load flow in the LabVIEW platform is needs to following steps to follow while implementing the model in a stand alone system.

- Real and imaginary part of the bus datas were given by using numeric control tool in the front panel and then The admittance matrix will be formed.
- Boolean Push button tool used here to check whether the voltage is present or not in the bus. If the voltage is available, then the given value will be taken for further calculations. If not, ideal value will be taken.
- For generator bus, the Reactive power (Q) value will be calculated. Then Q limit violation will be checked by In Range-Coerce tool
- By using the Real and reactive power of generator bus, the voltage generated will be calculated.
- For load bus, Voltage will be calculated by using the given real and reactive power in the block diagram panel.
- The output values of all the buses will be displayed in front panel

5. RESULTS

A simple Load flow calculator model has been implemented by using LabVIEW. The result was shown in the figure 3.

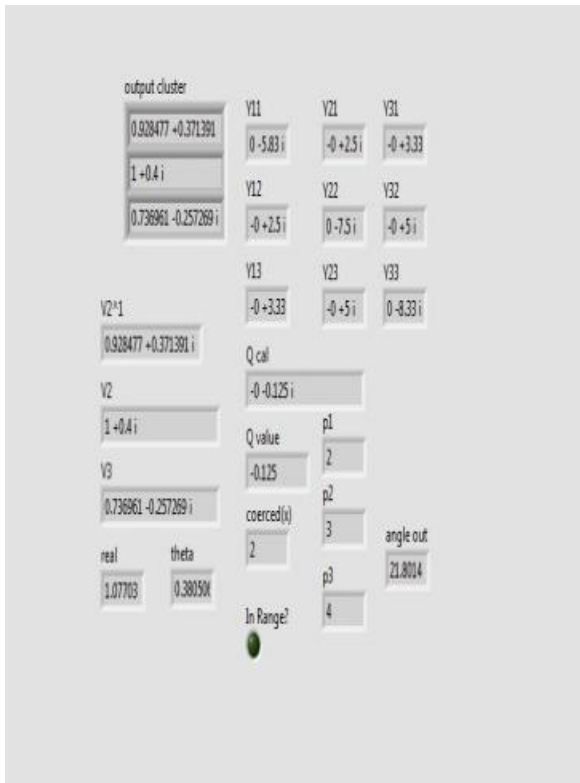


Figure 3 Load flow solution calculator output[11]

The figure 3 gives the load flow solution for the power system network in the LabVIEW window. The inputs are fed in the front panel of LabVIEW and the load flow runs automatically. Finally the load flow solution displays the output in the front panel. Using these approach different methods of load flow analysis can be done for different numbers of bus system for three phase power system. This innovative model is very much useful and handy for power engineers for calculating load flow calculation. Proposed work has been developed such that different versions of load flow algorithms can be implemented for load flow calculation.

6. CONCLUSION

An effective LabVIEW based load flow calculator model has been developed for a power system network. In this model, the power flow solutions were obtained for the system in Gauss Seidal method. Virtual load flow model has been implemented

model in LabVIEW will be useful to the engineers and educators. It can be extended in the other methods and recent versions of load flow solution. Accordingly the proposed model can be implemented for larger power system network. For analyzing the appearance of emergency operating conditions, post contingency analysis of the system need to be carried out as extension of this work. A practical implementation of this approach suggested in this paper was assessed based on 6, 8, 9, 10, 13 and 15 bus sample systems. Accordingly the proposed model can be implemented for large power systems network spread over geographically apart. As future scope the entire power system analysis such as contingency analysis, economic load dispatch, unit commitment, fault analysis etc can be implemented and LabVIEW based calculator can be developed.

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