International Journal of Electronics and
Communication Engineering (IJECE)
ISSN(P):2278-9901; ISSN(E): 2278-991X;
Vol. 4, Issue 6, Oct - Nov 2015, 17-22

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations
IASET

LOAD FLOW ANALYSIS OF 9 BUS RADIAL SYSTEM USING BFSLF ALGORITHM

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ABSTRACT

Power system is the most complex man made inter connected system with the combination of power generation, transmission and distribution to the consumer loads. In order to determine the behavior of the entire system i.e., planning and design, economic operation, stability...Etc of the power system the power flow or load studies plays vital role. By using this power flow solution we obtain magnitude and phase angle of voltage at each bus, real and reactive power flowing through the branches by using conventional iterative techniques like Gauss-seidal, Newton Raphson method, Fast decoupled methods. And this paper gives the complete load flow analysis of a radial distribution network with a proposed simple Backward/Forward sweep algorithm method which gives better convergence and takes full advantage of the radial structure of distribution systems tested for the IEEE 9 bus system implemented in MATLAB code.

KEYWORDS: Distribution Systems, Radial Distribution Systems, Power Flow Analysis, Proposed Algorithm

INTRODUCTION

Electrical energy is the essential ingredient for the development of industrial, domestic and all for the existence of the civilized world today. As the power demand is increasing day by day it is necessity to generate the power sufficiently from all the sources and transmit to the distributed system with the help of inter connected tie lines. Distribution system is the part of the power system gives the necessary information helps for the reliable power supply to consumers. Distribution of electric power is done by distribution networks and distribution networks consist of following main parts Distribution substation, Primary distribution feeder, Distribution Transformer, Distributors, and Service mains. There are three basic types of distribution system designs:

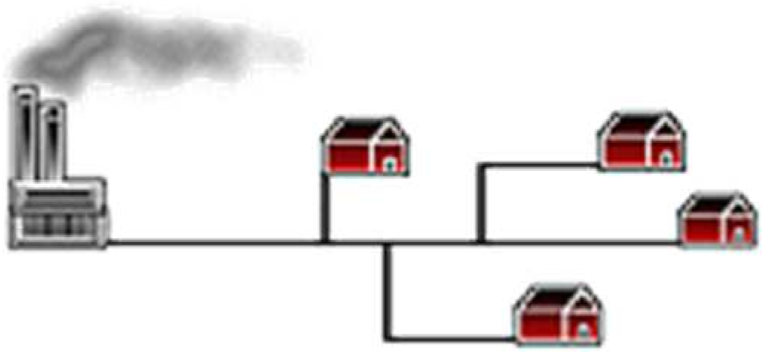

Figure 1

As you might expect, you can use combinations of these three systems, and radial distribution is frequently done.

Radial Distribution

The radial distribution is the cheapest to build, and is widely used in sparsely populated areas. A radial system has only one power source for a group of customers. A power failure, short-circuit, or a downed power line would interrupt power in the entire line which must be fixed before power can be restored.

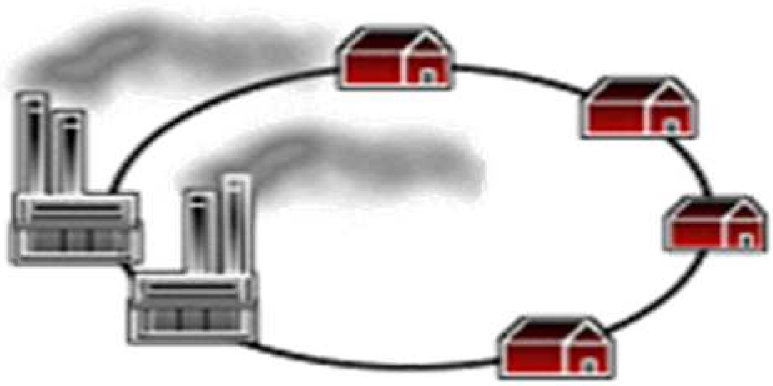

Figure 2

Loop

A loop system, as the name implies, loops through the service area and returns to the original point. The loop is usually tied into an alternate power source. By placing switches in strategic locations, the utility can supply power to the customer from either direction. If one source of power fails, switches are thrown (automatically or manually), and power can be fed to customers from the other source. The loop system provides better continuity of service than the radial system, with only short interruptions for switching. In the event of power failures due to faults on the line, the utility has only to find the fault and switch around it to restore service. The fault itself can then be repaired with a minimum of customer interruptions. The loop system is more expensive than the radial because more switches and conductors are required, but the resultant improved system reliability is often worth the price.

Network

Network systems are the most complicated and are interlocking loop systems. A given customer can be supplied from two, three, four, or more different power supplies. Obviously, the big advantage of such a system is added reliability. However, it is also the most expensive. For this reason it is usually used only in congested, high load density municipal or downtown areas.

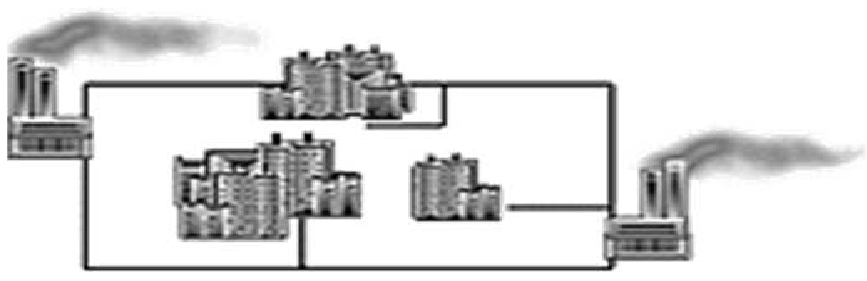

Figure 3

LOAD FLOW STUDIES

A planned and effective distribution network is the key to cope up with the ever increasing demand for domestic, industrial and commercial load. The load-flow study of radial distribution network is of prime importance for effective planning of load transfer. Load flow studies are important in planning and designing future expansion of power systems. The study gives steady state solutions of the voltages at all the buses, for a particular load condition. Different steady state solutions can be obtained, for different operating conditions, to help in planning, design and operation of the power system. Generally, load flow studies are limited to the transmission system, which involves bulk power transmission. Load flow studies throw light on some of the important aspects of the system operation, such as: violation of voltage magnitudes at the buses, overloading of lines, overloading of generators, stability margin reduction, indicated by power angle differences between buses linked by a line, effect of contingencies like line voltages, emergency shutdown of generators, etc. Load flow studies are required for deciding the economic operation of the power system. Hence, load flow studies play a vital role in power system studies. Thus the load flow problem consists of finding the power flows (real and reactive) and voltages of a network for given bus conditions. Because of the nonlinearity of the algebraic equations, describing the given power system, their solutions are obviously, based on the iterative methods only. The objective of any load-flow program is to produce the following information: Voltage magnitude and phase angle at each bus, Real and reactive power flowing in each element.

BACKWARD FORWARD PROPAGATION THEORY

One of the distinguishing features of the radial distribution network is that there is a unique path from any given bus slack to the source. This is the key feature exploited by the backward/forward sweep class algorithms. And these methods are based on updating voltages and currents or power flows along these unique paths. The general algorithm consists of two basic steps base on Kirchhoff's laws, backward sweep and forward sweep and this process repeated until the achieved the convergence criteria. The backward sweep starts from the farthest end as a function of end voltages determines the currents and update the voltages at each bus. i.e., the updated effective power flows in each branch are obtained in the backward propagation computation by considering the node voltages of previous iteration. It means the voltage values obtained in the forward path are held constant during the backward propagation and updated power flows in each branch are transmitted backward along the feeder using backward path. This indicates that the backward propagation starts at the extreme end node and proceeds towards source node. The active and reactive power flows are calculated. Forward propagation: The purpose of the forward propagation is to calculate the voltages at each node starting from the feeder source node. The feeder substation voltage is set at its actual value. During the forward propagation the effective power in each branch is held constant to the value obtained in backward walk. The node voltage magnitudes are calculated.

BACKWARD FORWARDS SWEEP POWER FLOW PROPOSED ALGORITHM

- In backward sweep assume the last end voltage equal to source voltage in radial distribution system.
- Calculate all the branch currents with the help of complex power ($S = VI^*$)
- Calculate the nearest node voltages from last end using branch currents and line impedance.
- Calculate all the node voltages up to the reference voltage.

- Compare the magnitude of the calculated new voltages with reference voltage.
- If the tolerance is less than the pre assumed value, than stop
- Else forward sweep starts from the reference node at given source voltage.
- Calculate all the node voltages in forward direction with branch current and impedance till the last node.
- Again compute the magnitude of new voltage with reference voltage.
- If the tolerance is less than the pre assumed value, than stop else backward process.
- Then the procedure is repeated until the solution is converged i.e., till it reaches the lesser value of pre assumed.
- After calculating all node voltages and line currents, the active and reactive power losses are calculated.
- In this paper the source voltage taken as 11KV with a tolerance 0.0001 p.u and the total no of iterations are 14 and the voltage magnitudes, phase angles, real and reactive powers are shown in table for a given 9 bus system.

RESULTS

The simulation using MATLAB is carried out on IEEE 9-bus system shown in Figure with the line data set and network buses data set for the 9-bus IEEE system as shown in below tables.

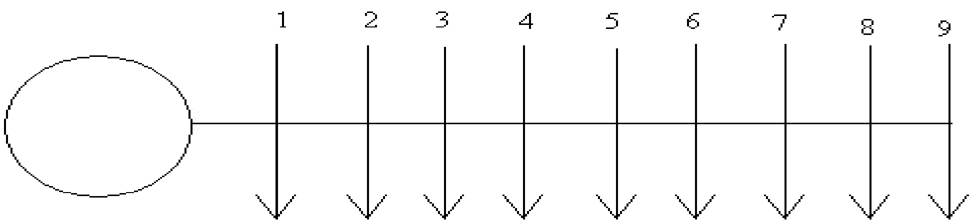

Figure 4: IEEE 9-Bus System

Line Data

Table 1

Sending End Bus	Receiving End Bus	R in Ohms	X in Ohms
0	1	0.1233	0.4127
1	2	0.0140	0.6050
2	3	0.7463	1.2050
3	4	0.6984	0.6084
4	5	1.9831	1.7276
5	6	0.9053	0.7886
6	7	2.0552	1.1640
7	8	4.7953	2.7160
8	9	5.3434	3.0264

Bus Data

Table 2

Bus No	Active Power in KW	Reactive Power in KVAR
1	1840	460
2	980	340
3	1790	446
4	1598	1840
5	1610	600
6	780	110
7	1150	60
8	980	130
9	1640	20

POWER FLOW RESULTS

Voltage Magnitudes, Phase Angles, Real and Reactive Power.

Total active power loss = 803.75 KW

Total Reactive power loss = 1036.35 KW

Table 3

Bus no	Voltage Magnitude in p u	Phase Angle in Degree	Branch		Active Line Losses in KW	Reactive Line Losses in KVAR
			Sending End	Receiving End		
1	1.0000	-0.5218	0	1	46.67	156.22
2	0.9929	-1.2678	1	2	3.97	171.86
3	0.9874	-2.3306	2	3	177.22	286.14
4	0.9634	-2.6519	3	4	114.40	99.65
5	0.9480	-3.7212	4	5	190.22	165.71
6	0.9172	-4.1367	5	6	47.77	41.61
7	0.9072	- 4.6184	6	7	75.74	42.89
8	0.8890	-5.4036	7	8	88.46	50.01
9	0.8587	-5.9902	8	9	39.30	22.26

CONCLUSIONS

This paper presents a new method called backward forward sweep algorithm which solve the load flow analysis in radial distribution system which uses very simple algebraic equations and Kirchhoff's laws as iteration techniques for mismatching the new calculated voltages and to the existing source voltage which gives the efficient results of voltage magnitude and line power losses. This study helps to improve the losses and voltage profile in radial distribution systems. Here a basic method proposed for a 9 bus system and the results obtained here helps to improve the voltage profile and system losses.

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