ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

Power Loss Reduction Index for Radial Distribution Systems

Gundugallu Peddanna[1], C Rajesh[2]

Assistant Professor, Dept. of EEE, SRIT College, Ananthapuramu, Andhrapradesh, India[1,2]

ABSTRACT: Distribution system is the system where the loads are directly connected. Due to connectivity of different types of load connection the R/X ratio is more which gives the high resistive nature for distribution system. Hence the distribution system inherently contains more power losses. If the power losses increase, as moving from sending end to receiving end in radial distribution system the voltage instability occurs. This condition is not good for electrical systems. Due to the nature of load and line impedance power loss occur in the radial system.
In this paper the main problem focused on which bus is more sensitive to get instability known as sensitive bus. To do this Power Loss Reduction Index (PLRI) has considered. This index gives which bus is more sensitive. Sensitive bus means the bus which is going to be affected by the abnormal conditions quickly such as faults, sudden changes in load etc.
In this paper the PLRI is evaluated for 10-bus, 12-bus, 13-bus and 15-bus radial distribution systems in MATLAB/SIMULINK environment.

KEYWORDS: Distribution System, Load Flows, PLRI and Sensitive Bus

I. INTRODUCTION

The distribution system contains more R/X ratio when compare to transmission system since loads are directly connected to distribution system. Due to this losses are more in distribution system than transmission system. The power losses, voltages in distribution system will be evaluated by using load flows techniques. The authors proposed different methods for radial distribution system in the past. After evaluation of the load flows, the number of authors proposed various methods to find sensitive bus in the past.
Kersting and Mendrive [1] have mentioned ladder theory based load flow techniques. Das [2] presented a load flow technique based on lateral, bus and branch numbering scheme. Goswami and Basu [3] presented a direct method for radial and mesh distribution system. In this paper simple Backward and Forward sweep method has used for load flow solution [4]. Avani [5] proposed an index based on voltage for sensitive node evaluation.

II. PROBLEM FORMULATION

$$\text{Power loss reduction index (PLRI)} = \frac{Powerloss(i) - \min(Powerloss)}{\max(Powerloss) - \min(Powerloss)} \quad (1)$$

Where, i is the branch number from 1 to total number of branches.
Here in order to find PLRI, first have to compensate the real power load at each bus. After compensating real power at each bus, load flows have to run again. From these load flows real power losses will be evaluated. From these real power losses at each branch the PLRI will be calculated by using equation (1).

III. METHODOLOGY FORMATION

Procedure for finding PLRI:
1. Run the load flows
2. Find bus voltages and branch power losses from the load flows.
3. Compensate the real power value of load at each bus.
4. Run the load flows again.
5. From this load flows evaluate the real power losses at each branch.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

6. Evaluate PLRI at each bus using equation (1).
7. Assign the bus having PLRI value equal to 1 as sensitive bus.

IV. RESULTS AND ANALYSIS

Test system-1: 10-bus radial distribution system

Table: The power loss reduction index for 10-bus radial distribution system

Bus Number	PLRI (per unit)
1	0
2	0.3769
3	0.0139
4	1.0000
5	0.6482
6	0.1802
7	0.0027
8	0.0075
9	0.0202
10	0

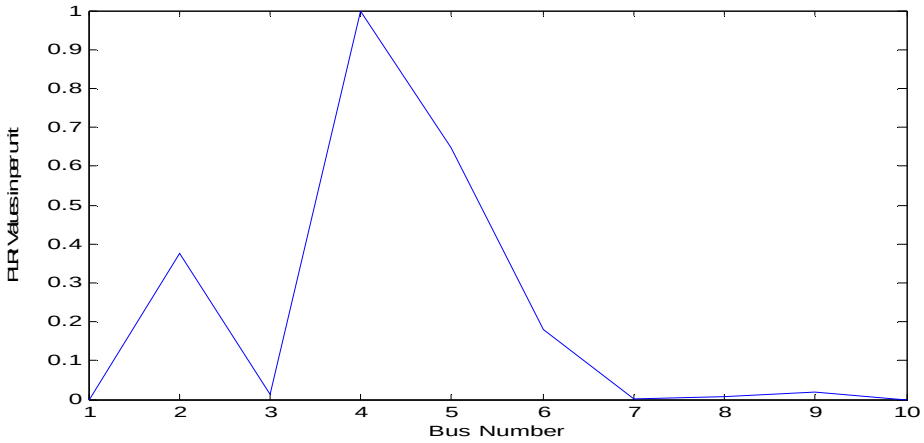

Figure1: power loss reduction index for 10-bus radial distribution system

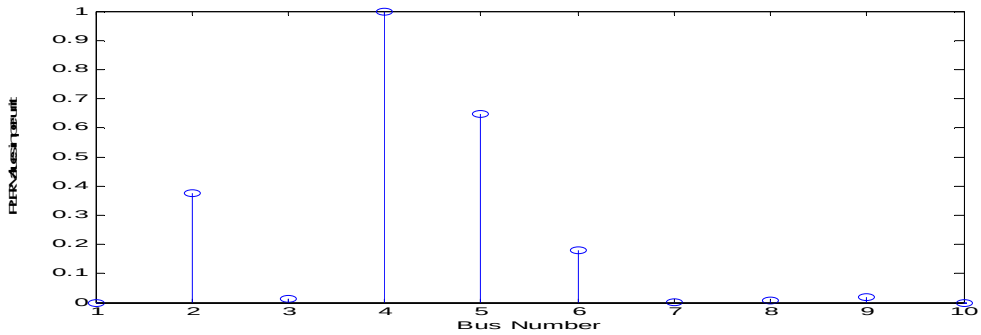

Figure 2: power loss reduction index for 10-bus radial distribution system

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

The table 1, figure 1 and figure 2 gives the values of power loss reduction index in per unit at each bus for 10-bus radial distribution system. Here it is observed that bus-4 has PLRI value as 1 per unit. Hence bus-4 is the sensitive bus for 10-bus radial distribution system.

Test system-2: 12-bus radial distribution system

Table 2: The power loss reduction index for 12-bus radial distribution system

Bus number	PLRI (per unit)
1	0
2	0.8145
3	0.6529
4	0.9453
5	1.0000
6	0.2709
7	0.2134
8	0.5370
9	0.3699
10	0.0855
11	0.0155
12	0

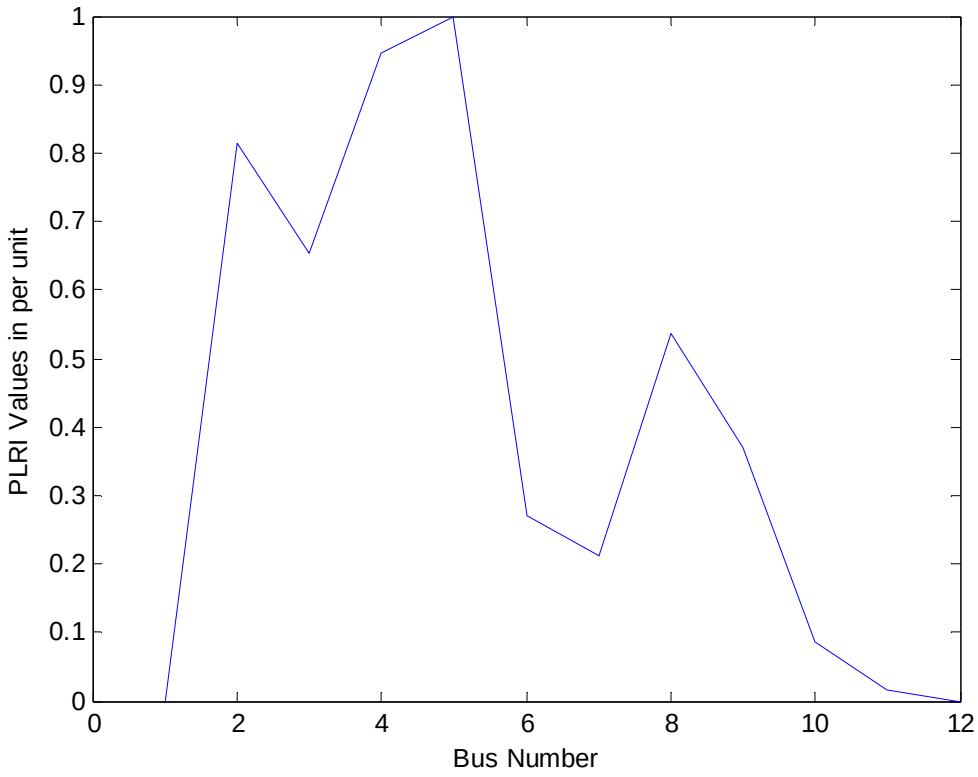

Figure 3: The power loss reduction index for 12-bus radial distribution system

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

Table-2 and figure 3 explains the details of PLRI values of 12-bus radial distribution system. Here it is clear that bus-5 has PLRI value as 1 per unit. So the sensitive bus is bus-5 for 12-bus radial distribution system.

Test system-3: 13-bus radial distribution system

Table 3: The power loss reduction index values for 13-bus radial distribution system

Bus number	PLRI (per unit)
1	0.0000
2	1.0000
3	0.8421
4	0.1836
5	0.2772
6	0.1161
7	0.2633
8	0.0990
9	0.0699
10	0.0586
11	0.0238
12	0.0148
13	0.0000

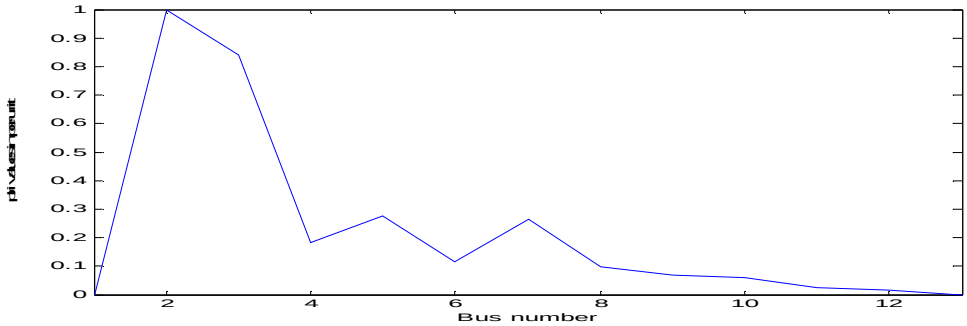

Figure 4: The power loss reduction index for 13-bus radial distribution system

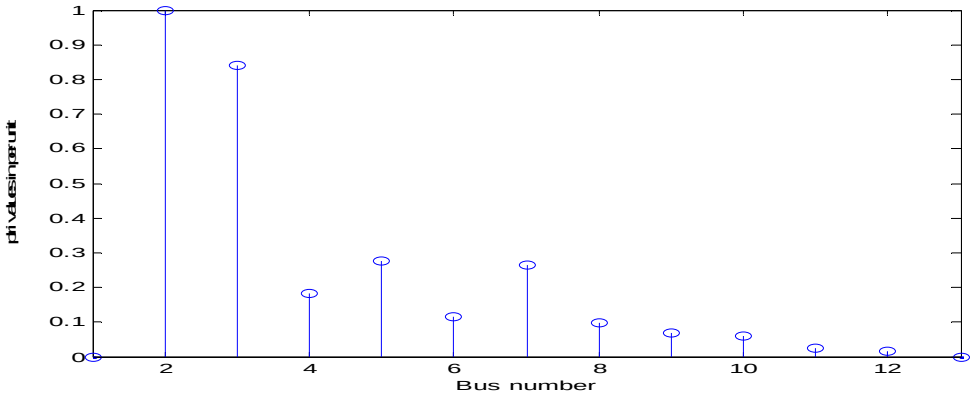

Figure 5: The power loss reduction index for 13-bus radial distribution system

Table 3, figure 4 and figure 5 show the PLRI values of 13-bus radial distribution system. Here bus-2 has PLRI as 1 per unit hence bus-2 is the sensitive bus for 13-bus radial distribution system.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

Test system-4: 15-bus radial distribution system

Table 4: The power loss reduction index values for 15-bus radial distribution system

Bus number	PLRI (per unit)
1	0
2	1.0000
3	0.2971
4	0.0632
5	0
6	0.0113
7	0.0001
8	0.1520
9	0.0090
10	0.0015
11	0.0559
12	0.0143
13	0.0005
14	0.0039
15	0.0102

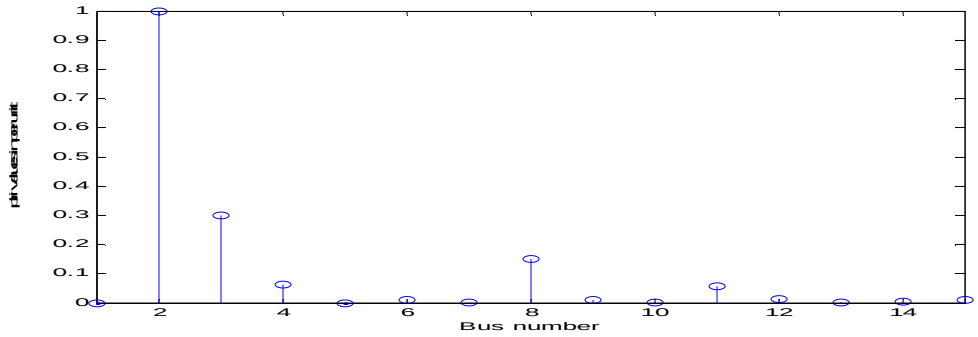

Figure 6: The power loss reduction index for 15-bus radial distribution system

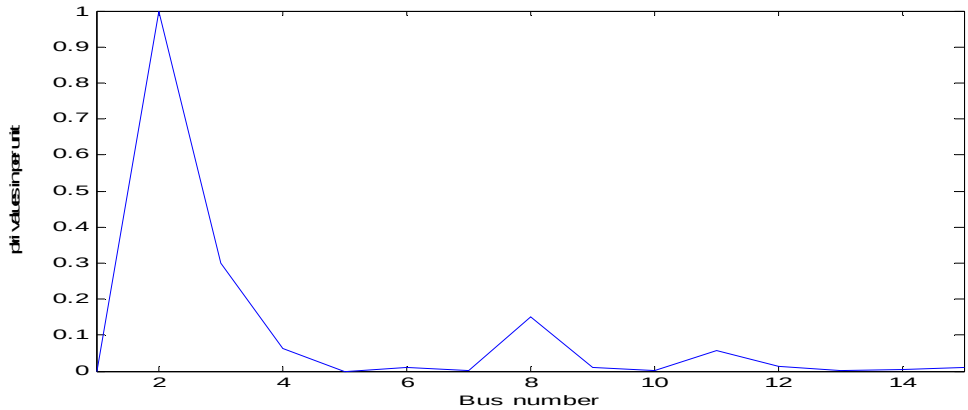

Figure 7: The power loss reduction index for 15-bus radial distribution system

Table 4, figure 6 and figure 7 mention the power loss reduction index for 15-bus radial distribution system. The bus-2 has PLRI value as 1 per unit. Hence bus-2 is sensitive bus for 15-bus radial distribution system.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 9, September 2016

V. CONCLUSION

The sensitive node plays crucial role in power system maintenance and planning. The sensitive node gives an idea how the distribution system buses behaving towards faults and abnormal conditions. In this paper the sensitive node is evaluated for 10-bus, 12-bus, 13-bus and 15-bus radial distribution systems.

REFERENCES

1. W. H. Kersting., and D. L. Mendrive, 'An application of ladder network theory to the solution of three phase radial load flow problem' IEEE PES winter meeting, New York, January 1976, paper A 76 044-8.
2. D. Das, H. S. Nagi, and D.P. Kothari, 'Novel method for solving radial distribution networks' IEEE Proc.-Gener. Transm. Distrib., Vol. 141, No. 4, July 1994.
3. S. K. Goswami and S. K. Basu, 'Direct solution of distribution systems', IEEE Proc. C, 1991, 188, (1), pp. 78-88.
4. A. D. Rana, J. B. Darji Mosam Pandya, 'Backward and forward sweep load flow algorithm for radial distribution system' International journal for science Research & Development. Vol. 2, Issue 01, 2014, pp. 398-400.
5. A. Jigar Pujara, Geetanjali Vaidya, 'Voltage stability index of radial distribution network' IEEE Proceedings of ICETECT 2011, pp. 180-185.

BIOGRAPHY

Gundugallu Peddanna was born in Ananthapuramu, A. P., India on June 03, 1989. He received B. Tech Degree in Electrical and Electronics Engineering from JNTUA College of Engineering, Pulivendula, A. P. India in 2010. He completed M. Tech in Electrical Engineering with specialization in Electrical Power Systems from JNTUA College of Engineering, Ananthapuramu, A. P., India in 2014. Currently, he is Assistant Professor, at Department of Electrical & Electronics Engineering, Srinivasa Ramanujan Institute of Technology, Ananthapuramu, A. P, India. His area of interest includes Electrical Distribution Systems, Analysis of Distributed Generation, Optimization Techniques and Multi Level Inverters.

C Rajesh was born in Tirupati, A. P., India on Feb 19, 1985. He received B. Tech Degree in Electrical and Electronics Engineering from Sri Venkatesa Perumal College of Engineering and Technology, Puttur, A.P. India in 2007. He completed M. Tech inElectrical and Electronics Engineering with specialization in Electrical Power Systems from Sri Venkatesa Perumal College of Engineering and Technology, Puttur, A. P., India in 2012. Currently, he is Assistant Professor, at Department of Electrical &Electronics Engineering, Srinivasa Ramanujan Institute of Technology, Ananthapuramu, A.P, India. His area of interest includes Electrical Distribution Systems, Analysis of Distributed Generation, Optimization Techniques and Multi Level Inverters.