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Analysis and Simulation of Faults in Power Distribution Systems with Distributed Generation

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***Abstract*—This paper shows the modeling of 11kV distribution system with 18 bus lines with and without DG and then analyses of fault is done. These analyses are based on the investigation of the impact of DGs on the efficiency at fault location. The fault location is made fixed. The location of DG is changed and fault power is calculated at fault location. Thus location of DG is calculated by minimum fault power consumption for typical distribution system. Due to the increase in DG penetration and the high incidence of faults in distribution systems, it is necessary to study location of DGs for minimum fault power consumption. The results will support the choice of suitable location of DG in distribution system.**

Keywords— distributed generation; power distribution systems; fault location; minimum fault power consumption.

I. INTRODUCTION

Distributed generation (DG) is an interesting topic that has drawn attention of electrical engineers in recent years. Distribution system is the link between the end user and the utility system, it is the most crucial part of the power system and it is facing a lot of threats that cause a power interruption to customers, it can be stated that a great percentage of end users' power outages are due to distribution networks, it can also occur due to mal functioning of the networks protection equipment as a result of adding a Distributed Generation (DG) to increase the network's reliability. DG is an alternative small rated power generation unit added to the distribution network to cover the supply of some loads Today worldwide distributed generation (DG) takes a very important role in the operation of distribution electric power systems The presence of these generation units in distribution systems although has many advantages and benefits but has to be applied after performing studies and investigations due to their complexities in operation, control and protection of network. DGs are connected to distribution networks with the aim of reliability improving: on the other hand installation of DG may destroy the protection coordination which causes the system reliability to become worse. This project we study the location of single phase fault observed and simulated a distribution system containing a DG for three phase fault. The location of DG is changed for minimum fault power consumption for typical distribution system.

Conventional electric distribution system is radial in nature, supplied at one end through a main source. These networks generally have a simple protection system usually implemented using relays, fuses and circuit breakers. Considerable attention has recently been paid to the use of distributed generation in electric distribution system. The impact of DG on the distribution and transmission system today are not adequately quantified but are believed to be relatively low. Currently about 90% of connected DG capacity is on the customer side of the meter, customer side DG meter are typically small, the current penetration level of DG is small and there is a lack of monitoring DG system output and of the effects of DG system on the grid.

II. METHODOLOGY

The three models are used to perform the tests for finding the suitable location of DG with minimum power consumption by analysing the fault, here location of fault is made fixed. Different waveforms of active and reactive power of each model are generated, now the analysis is done by calculating the fault power.

$$P_f = \sqrt{(kW)^2 + (kVAR)^2}$$

HERE

P_f = Fault Power
KW = Active power
KVAR = Reactive Power

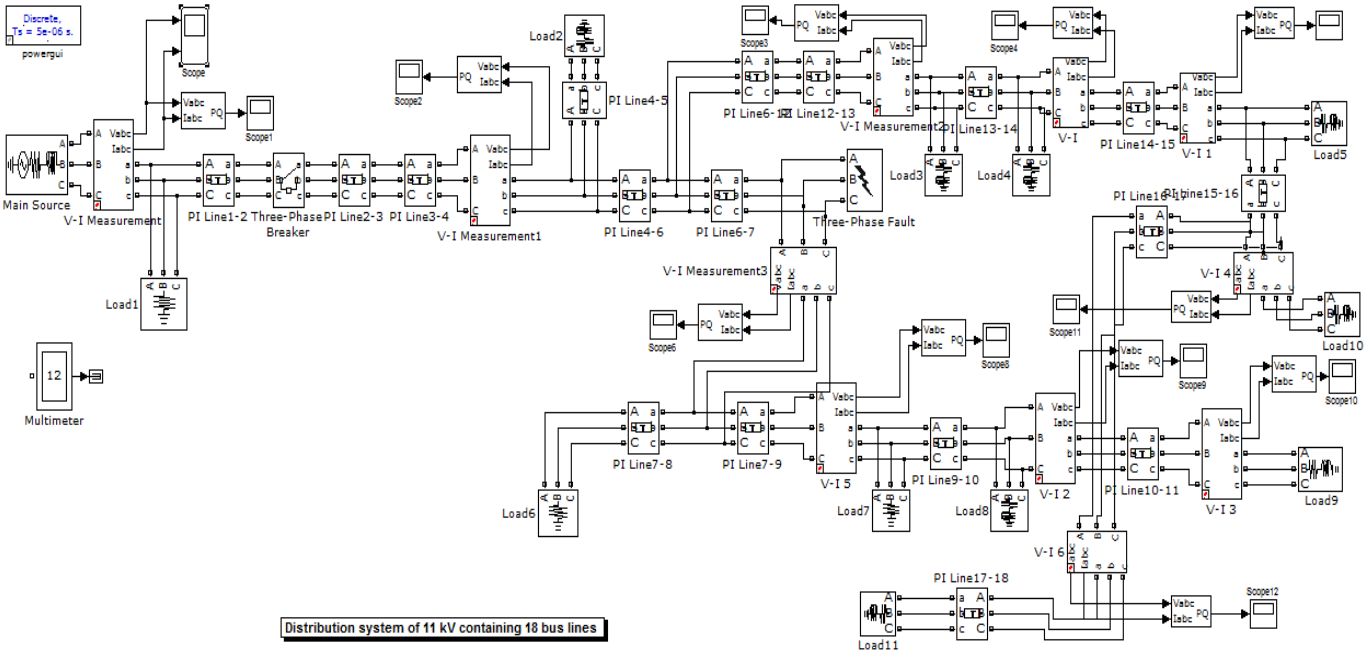
Now after calculating the fault power of all three models, model whose P_f value is minimum, will be the best model and best location of DG.

III. SIMULATION MODEL

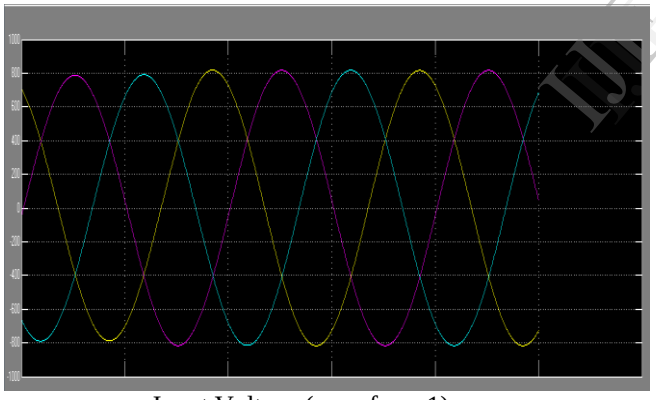
Here we have developed an application in Matlab/Simulink that can obtain the distribution system of 11 kV containing 18 bus lines and then fault power is analyzed at fault location.

A. Fault Analysis without DG

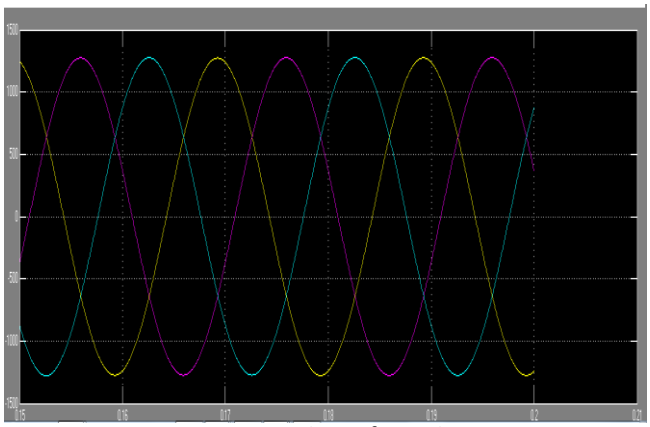
It has been developed a model of distribution system of 11kV containing 18 bus lines without DG in Matlab/Simulink. The fault location is made fixed and fault power is calculated by Active power and Reactive power waveform.



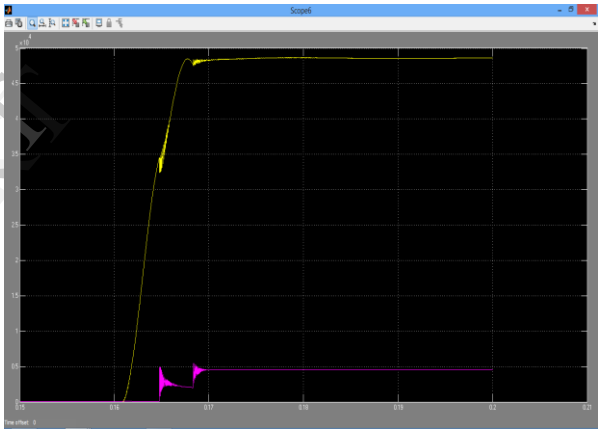
Three phase is supply is used as an input supply and then the location of fault is made fixed, waveform 1 shows the input three phase voltage supplied to distribution system, waveform 2 shows three phase input current. Now at the fault location Active and Reactive power is calculated shown in waveform 3.



Input Voltage (waveform 1)



Input Current (waveform 2)



Active power (Yellow) and Reactive Power (pink) (Waveform 3)

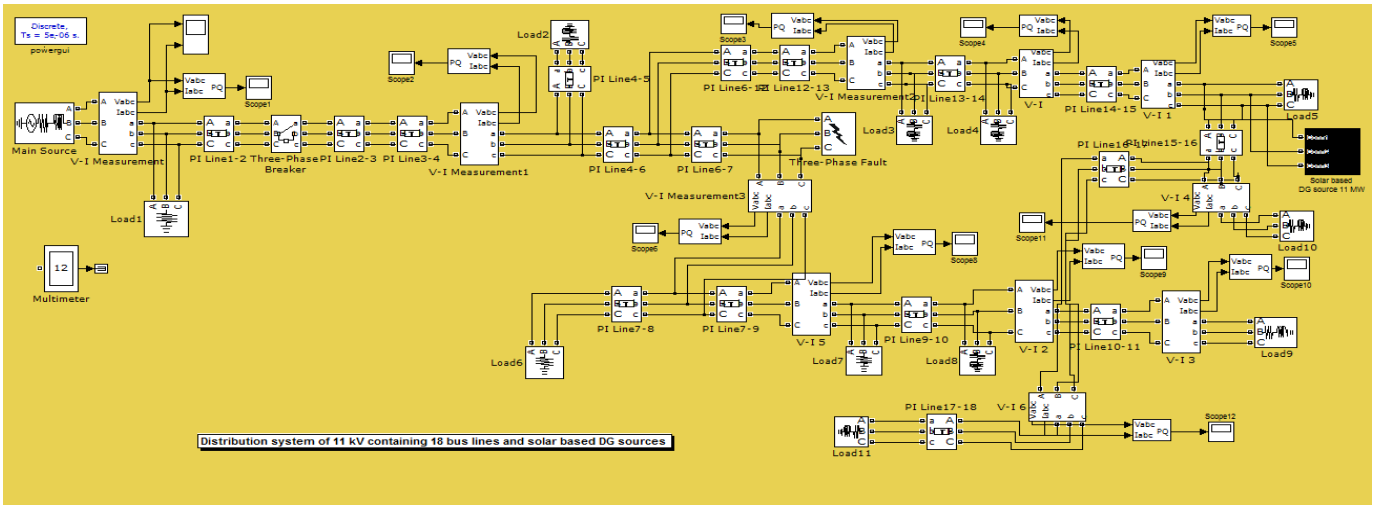
B. *Fault Analysis with DG*

Again the model of 11kV with 18 bus lines is reconstructed but now DG is connected to it. DGs are distributed generation units of electric power connected to distribution network.

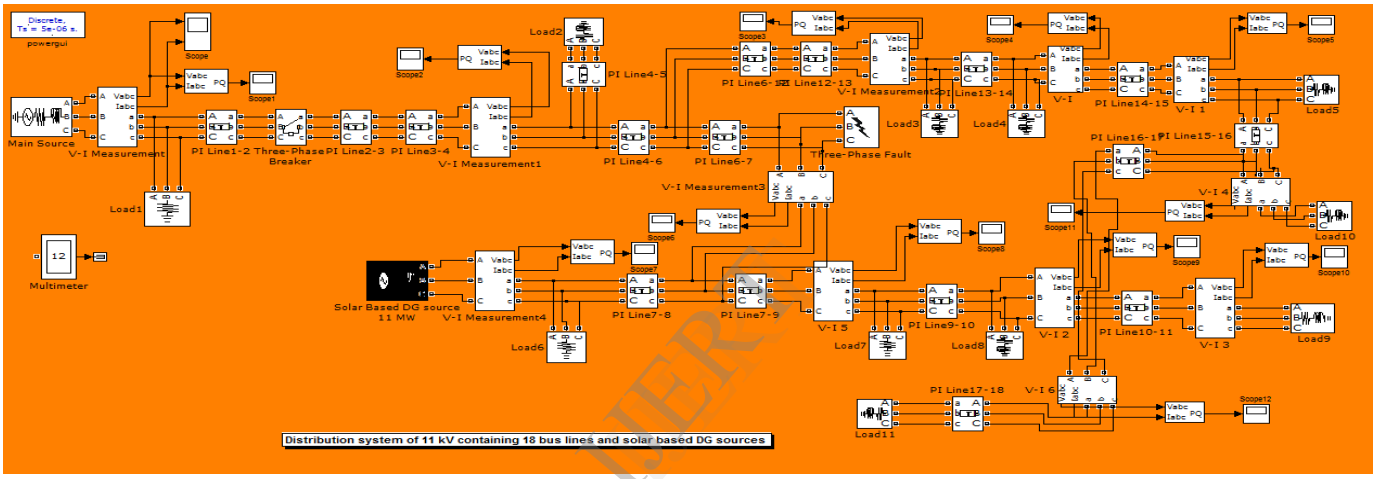
In order to obtain maximum benefit from the distributed generator, suitable location and sizing has to be determined before its installation. The technique developed in obtaining suitable location for DG is by studying active and reactive power (fault power) at fault location.

Here in this paper we changed the location of DG and then fault analysis is done i.e. active and reactive power at fault location is calculated.

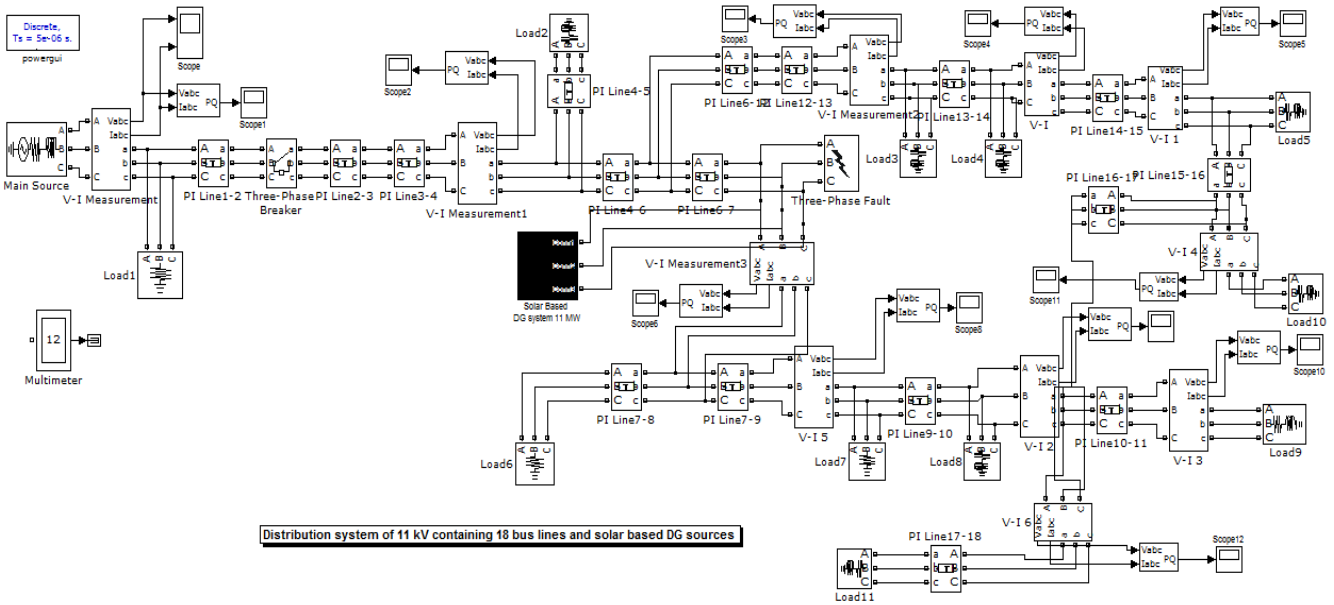
Here are some locations were DG is located and respective active and reactive power waveform is studied to find best location. Model in which fault power is minimum will be the best model for the location of DG.



Model 1

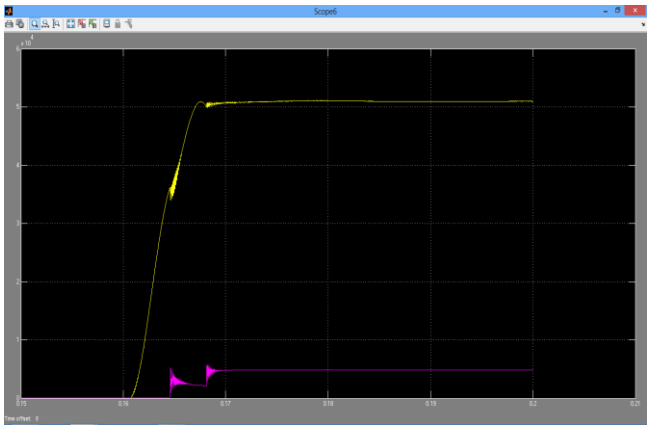


Model 2

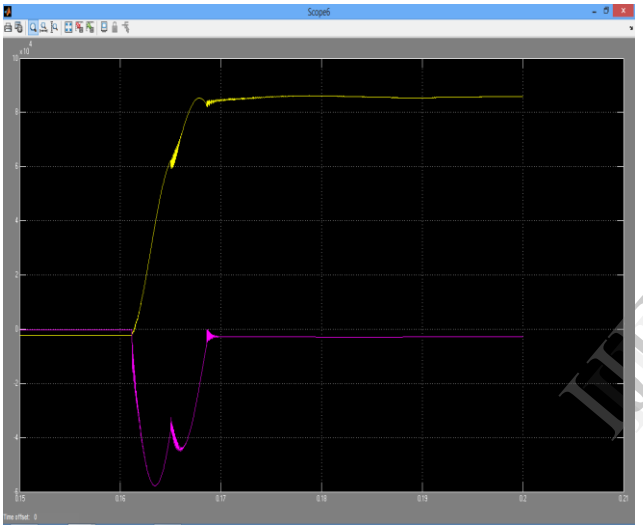


Model 3

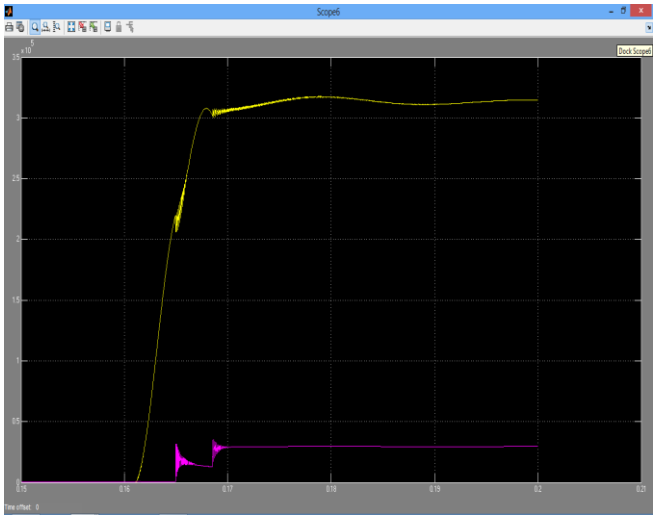
Three models were studied by changing the location of DG and respective waveforms were generated near fault of active and reactive power.



Active power(yellow) and Reactive power (pink) of Model 1



Active power(yellow) and Reactive power (pink) of Model 2



Active power(yellow) and Reactive power (pink) of Model 3

IV. ADVANTAGES AND DISADVANTAGES

The presence of DGs in distribution networks, like many other technologies, has some disadvantages along with many advantages it can have (Dugan & McDermott, 2002). Among advantages of DGs one can mention improvement in power quality and reliability and reduction of loss, meanwhile using DGs leads to complexity in operation, control and protection of distribution systems (Kauhaniemi & Kumpulainen, 2004). Injection of DGs currents to a distribution network results in losing radial configuration and consequently losing the existing coordination among protection devices (Girgis & Brahma, 2001). The extent at which protection coordination is affected depends on the size, type and location of DG, in some cases coordination is lost completely and in other cases the coordination range diminishes (Doyle, 2002). Regarding the influence of DGs on protection of distribution systems, many researchers have been performed so far as well as some researches concerning how to tackle the resultant problems of applying DGs.

V. RESULTS

After analyzing the fault with and without DG certain results were generated.

The fault power is as follow:-

- Without DG P=50KW, Q=5KVAR
- With DG
  Distribution Network 1 P=51KW, Q=4600VAR
  Distribution Network 2 P=85KW, Q=0
  Distribution Network 3 P=314KW, Q=30KVAR

After calculation model 1 is best as it has minimum fault power

So, the conclusion is that the far the DG is from fault location the more isolated it is.

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