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# VOLTAGE DIPS SIMULATION IN DISTRIBUTION SYSTEMS IN MALACCA MALAYSIA

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**Abstract- The objective of this paper is to present the voltage dips simulation in distribution systems in Malacca, Malaysia. A case study is carried out on load behaviour during voltage dips in distribution system. In this paper most of the work is focused on the voltage dip due to single line to ground faults, three phase to ground faults and induction motor starting. Understanding significant characteristic of voltage dip is important before mitigation issues can be dealt with. Subsequently correct mitigation techniques are proposed. The simulation results were performed in distribution system using PSCAD/EMTDC software.**

**Keywords** – ***Voltage sag, distribution system,three phase fault to ground fault*.**

## I. INTRODUCTION

Power quality problems generally appear in the form of voltage dip, transients, and harmonics. From these three broad categories of power quality problems, voltage sags account the most disturbances experienced by industrial customers. Voltage dips generally refers to instantaneous short-duration voltage variations, typical duration of voltage dips is between 0.5 to 30 cycles with typical magnitude of 0.1 – 0.9 per-unit. The consequences of voltage dips to sensitive loads can be severe, such as production losses, scrap product, plant shutdown, and unnecessary maintenance to mention just a few examples [1,2 ].

Lately attention has been paid to voltage dips, in addition to supply interruptions. According to some estimates voltage dips may cause even more severe problems than interruptions.

There are two sources of voltage dips: external and internal. In the course of normal utility operations, however, many things can cause voltage dips. Storms are the most common cause of external dips and momentary interruptions in most areas. Many types of electronic equipment are sensitive to voltage dips, including variable speed drive controls, motor starter contactor, control power supply and control relays [3].

## II. SYSTEM COMPONENTS

A distribution system comprises a number of loads conveniently supplied by circuits from the nearest distribution point. The distribution circuit configuration depends on the particular load requirements.
The distribution system under study is presented in fig.1.Basically, 11kV network is the main distribution voltage used in Malacca. The 11kV is step down from the 132kV transmission voltage via power Transformer in Main Intake Distribution Substation (PMU – Pencawang Masuk Utama = the main take substation). From the PMU, the 11kV is distributed into many feeders via Main Switch Station (SSU – Stesen Suis Utama) and each feeder consist a few substations (PE – Pencawang Elektrik) of 11kV that stepped down to 415V via step down power transformer. Sometimes, PE called as Ring Main Unit (RMU) Switchgear. This is because the connection of switchgears is in ring configuration. All of these types of substations are interconnected with close loop configuration (ring configuration) and are separated with the NOP (Normal Open Point).

There are various types of customers using the electricity with different voltages and phases. For the domestic category, which consist residents of houses in urban and rural side, they use single-phase 240V and sometimes three-phase 415V for the consumption of high load in a three phase loads such as bungalow houses. For the commercial category, they use three

phase 415V. For the industrial category, there are 2 types of this Large Power Consumer (LPC), which, are three, phase, and 11kV and direct from transmission line, three phase 132kV.
The sequence of Distribution single line diagram in Malacca is depicted in Fig.1 of the actual power distribution where the monitoring is being conducted.

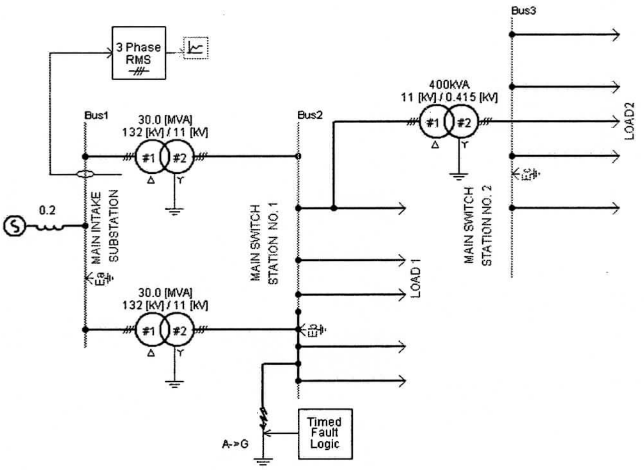


Figure 1: An example of power distribution system in Malacca

The sub-system supplies mostly commercial customers, and a few residential and light industrial customers. Faults in the distribution system might cause voltage dips. The location of fault, type of fault, fault clearing time and the electrical system configuration will also affect the voltage dip. Most of the faults on the utility transmission and distribution system are single line to ground faults (SLGF's). These faults are the most common cause of voltages dips for distribution system customer [1]

## III. EFFECT OF VOLTAGE DIPS

Dips are normally categorized only by depth and duration. Magnitude, duration and phase jumps are the fundamental properties of voltage dips. These three parameters affect the performance of the customer's equipment. Initially, the consequences of voltage dip considered only the momentary drop in voltage magnitude for a short duration of time. Fig.2 show a voltage dip in one phase [4].

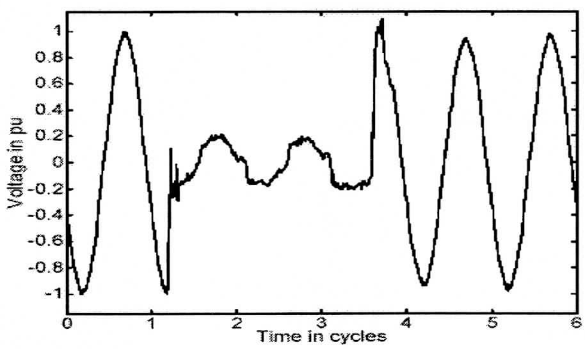


Figure 2 Voltage Dip in one phase

### A. Voltage Sag at Point of Common Coupling (PCC)

For a radial system, the fast assessment of voltage dip is adopted. The magnitude of the voltage dip is given by [2].

$$V_{dip} = \frac{Z_F}{Z_S + Z_F} E \quad (1)$$

Hence to calculate the voltage sag magnitude as a function of the distance L, the equation above become [2]

$$V_{dip} = \frac{zL}{Z_s + zL} E \quad (2)$$

Here this equation corresponds to the voltage divider as shown in Fig. 2

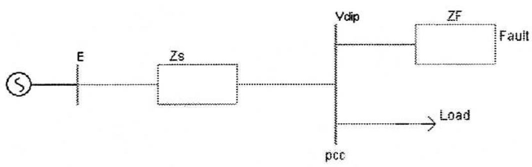


Figure 3 Voltage divider model at point of common point

**B. Voltage Dip Due to Starting of Induction Motors**

The equivalent circuit for the voltage dip due to induction motor is shown in Fig. 4. Here the voltage experienced by the other load fed from the same bus as the motor expressed by the voltage divider equation [2]

$$V_{dip} = \frac{Z_M}{Z_s + Z_M} E \quad (3)$$

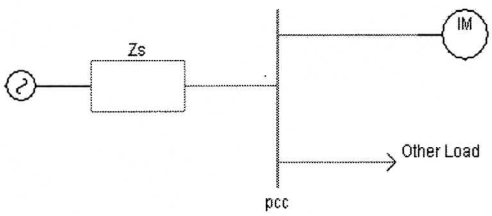


Figure 4 Equivalent circuit for induction motor starting

## IV. SIMULATION RESULTS AND DISCUSSION

The simulation is mainly focusing on voltage dip due to starting of induction motor. In the simulation study, a voltage dip in the system is created by the three-phase fault component from the PSCAD/EMTDC software's library [3].

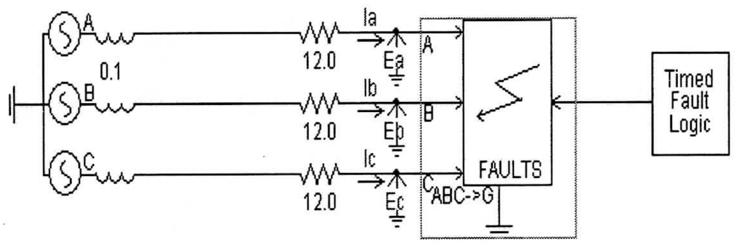


Figure 5 Three phase fault Component to Introduce Voltage dip

Fig. 5 shows the component applied to generate a voltage dip. The system was simulated for 0.4 seconds with a three-phase balanced fault occurring at time 0.2 sec for of duration of 0. 2 sec. Fig. 6 voltage and current profiles of the system and can be observed that due to the three-phase fault, voltage dip has occurred. The depth of dip can be changed by changing the fault impedance.

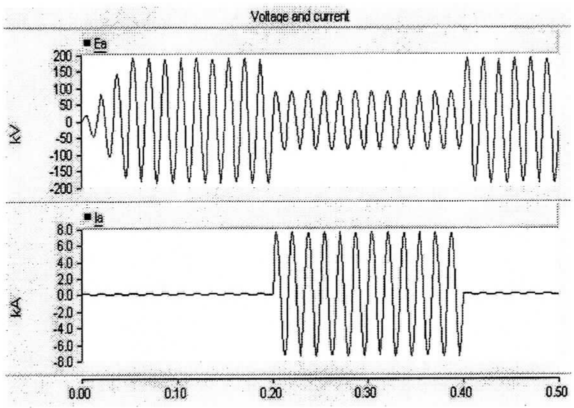


Figure 6 Three phase voltage (kV) and current (kA)

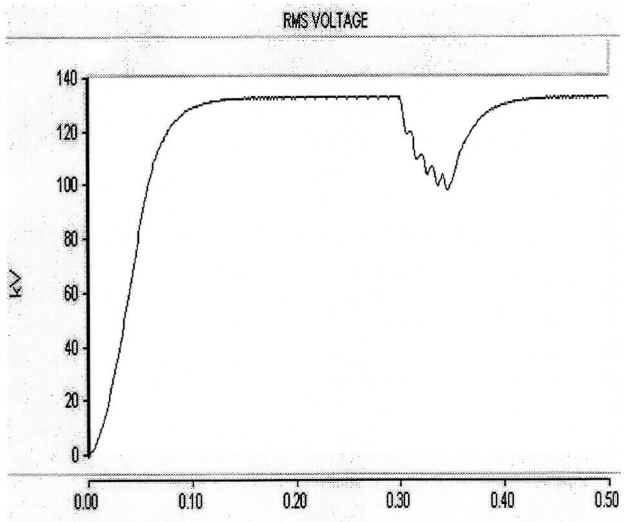


Figure 7 RMS Voltage showing single phase fault on a 11kV

Fig. 7 show three phase RMS voltage at 132kV due to fault of 300ms on a 11kV distribution system. The fault has occurred as shown in Fig.1 is a single line to ground fault.

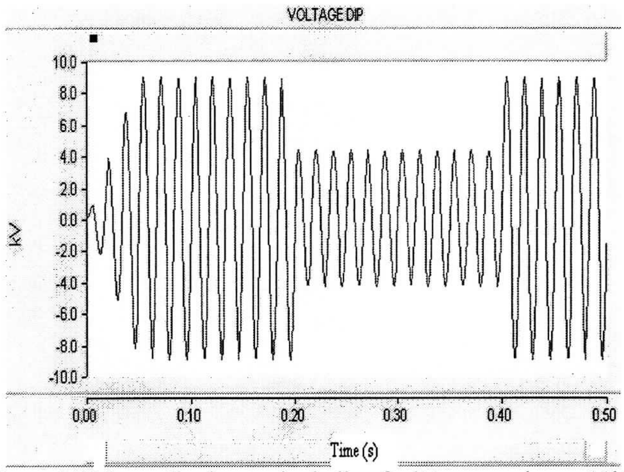

Figure 8 Voltage dip due to single line fault to ground on a 11kV

Fig. 8 show voltage dip due to fault on a 11kV distribution system. The fault causes a voltage dip in the system.

Single line to ground faults give less severe problems to motor loads than three phase ground faults. However, voltage recovery after the fault is still affected.

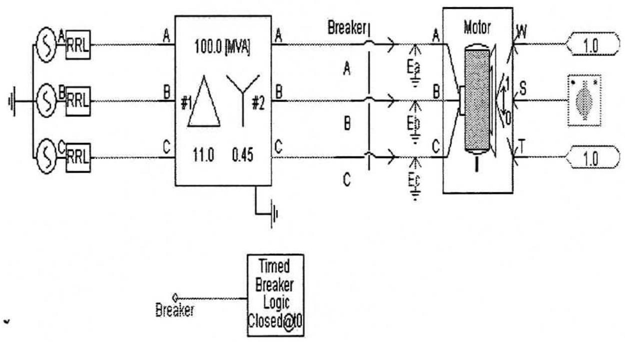

Figure 9 A simplified model of the schematic circuit

Fig. 9 show a simplified model of the schematic circuit is being constructed to simulate some event of voltage dip due to starting motors. Voltmeters are placed at different locations to record the voltage dips of all the three phases (Phase A, B and C). The three phase meters are placed to measure the voltage magnitude of the three phases. When the control panel switch closed approximately at 1 sec, the induction motor started to run. At starting, the induction motor draws more current than when the motor is running at their rated speed. Consequently, as shown on the simulated results in Fig.10 all three phases experienced voltage dip. The voltage dip will linger around for approximately a few milliseconds until the induction motor returned to their normal speed.

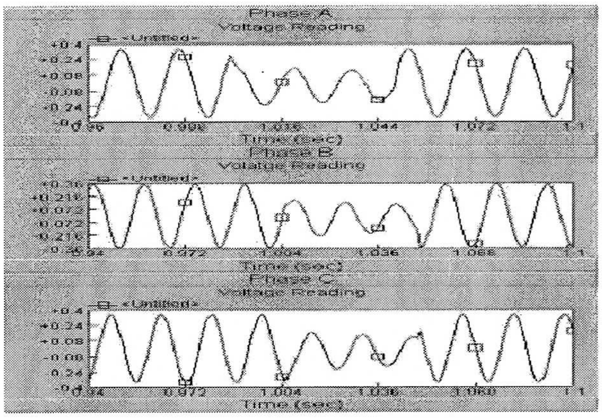


Figure 10 Simulation result of voltage magnitude at certain location

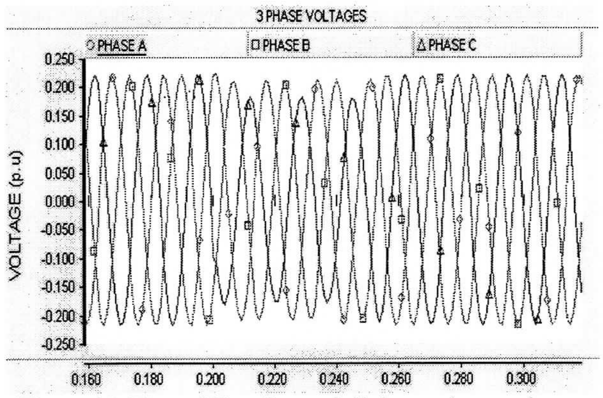


Figure 11 Three Waveform of all three phase voltages

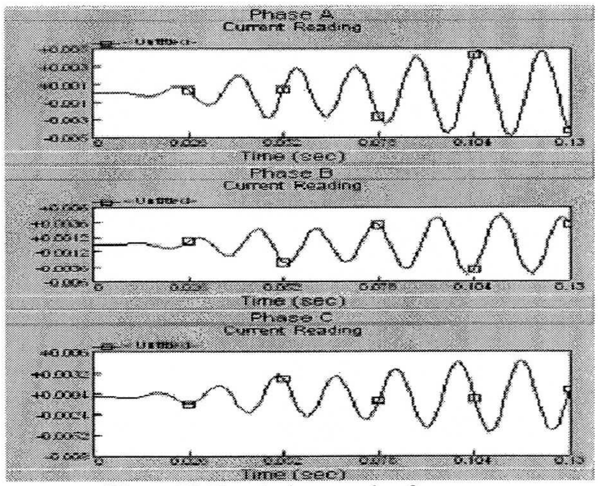


Figure12 Simulation result of current

Fig.12 show current waveform of the starting for induction motor. There is a sudden increase in the drawing of current.

## V. METHODS TO MITIGATE THE EFFECTS OF VOLTAGE DIPS

Voltage dip mitigation can be done through changes in power system configuration, increasing equipment immunity or the use of mitigation devices. Fault can be reduced with the use of lightning arrestor or using underground cables [5].

In the long run, the best solution to mitigate the problems caused by voltage dips will probably be to purchase voltage dip tolerant equipment, but this would take a very long time. For present day needs there are voltage-supporting equipment that can be connected to existing equipment or system.

Reducing fault-clearing time leads to less severe voltage dips. Modern digital relays enable short tripping times, which may in some cases be a very cost effective way to mitigate voltage dips. An interesting approach could be the combination of power conditioning equipment and fast protection. The protection would reduce the duration of the dip so that the voltage supporting equipment would be able to hold high enough for critical component.

## VII. CONCLUSION

Common voltage dips phenomena are observed in the simulation. Simulations of the respective power disturbances in the distribution are successfully produce through the application of PSCAD/EMTDC software. Due to usage of induction motors in the distribution voltage dip activities usually occur.

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