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A Novel Scheme of Multiple Identification of Faults in the Transmission Line

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Abstract: Recognition and arrangement of current-voltage, power fluctuations are critical functions for the safety of the power system (PS). Many perturbations of power quality (PQ) are unpredictable and ephemeral, and the demand for voltage and current recognition and arrangement is confirmed. By using Fast Fourier transform, expert systems, and neural networks, certain intelligent system technologies dominate fault analysis. As expected, there are five types of issues that include sag and swell, ripple, transient fluctuation, interruption and natural waveform. In this paper, we study the transmission line faults for voltage drop, voltage swell, and transient voltage. Power supply and traffic transmission leakage have been major problems for electricity providers and consumers. Much of the disturbance is non-stationary and intermittent, needing specialized methods and techniques for PQ disturbance research. This article provides a full collection of MATLAB / Simulink models to simulate different energy efficiency disturbances. This paper implements power quality disturbance in the model Matlab/ Simulink. The model provided can be used to simulate various disturbances of energy quality and waveforms for analysis and research into power quality, and to help to develop educational programs and understand the energy quality. This would concentrate on what are PQ problems and current approaches to evaluate and classify such problems.

Keywords: Power Quality(PQ), Transmission line fault, power quality issues, Power System (PS), Voltage sag, swell and transient.

I. INTRODUCTION

The term PQ itself has various definitions from the utility, manufacturer, and consumer perspectives. We also understand that PS is extensive network connectivity consisting mainly of three components, transmission, electricity generation, power distribution. The created electrical energy is supplied to customers, for which the transmission line needs a system built over a long network. Hence PQ's clarification is specifically for all market sectors. Typically, electricity is generated through a sinusoidal waveform.

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The performance of electrical power is more important because the distortion of electrical supply is one of the main problems facing the industry, disturbance such as voltage drop, tension swelling with/without harmonic, temporary disruption of harmonic distortion, notch, flicker, flame, and transients causing problems such as breakdown, instability, short life, failure of electrical equipment. Turning off and on the greater condenser load can allow the voltage to rise. Current, the use of semiconductor switching systems, and non-linear power loads can trigger failures that trigger voltage drops or instant interruptions, harmonic distortion, and voltage and current notching, electronic power for instance rectifier or inverter.

Power line polarizing or condenser inverting can cause transients. Sinusoidal waveforms may be transformed using known general parameters of the device. It produces sinusoidal waveforms for all market industries in India and supplies alternately 220/240 volts at 50 Hz level.

Therefore, no matter what the change is a pure sine wave must be generated. The concept of PQ is to adjust the amplitude of voltage V and current signal I in PS, which is almost a sine wave, particularly when it changes at a natural frequency most of the time. Ideally, other aspects of PQ intervention with the power delivery network should continue.

PQ interference is primarily focused on voltage amplitude changes, which can occur in the form of voltage drops, voltage expansion, transient fluctuations, and interruptions.

Power quality has recently become a pressing concern in the industrial and university sectors [2-5].

This is attributed to the rise in the number of disruptive loads in industry and the public sector, and the uncertainty related to the existence of such loads.

These problems are generally called PQ interference, which is the variation in voltage or current compared to the ideal waveform.

The existence of PQ intervention may decrease the electrical characteristics of the power system in which it exists, which can contribute to a shorter performance and service life of energetically efficient power system based equipment. In particular, customers are the group whose loads face major adverse consequences, attributable to PQ problems or theoretically described as power intervention. Such disruptions rising user load output and quality, in particular electronic loads with electricity.

The phrase PQ itself has various meanings from the viewpoint of the services, suppliers, and customers. PQ is commonly classified as controlling and grounding the equipment in a manner appropriate for the equipment's service. The study would explain what problems relevant to PQ are, and the current strategies for evaluating and defining such concerns.

II. POWER QUALITY ANALYSIS

A. PQ Analysis

Different sources [2-3] refuse to allow it to see eruptions in PQ. This provides the necessary detailed information for various PQs in the power distribution scenario in [2]. "Low power efficiency" usually means that the power difference is large enough due to equipment failure or malfunction. "High-quality energy" means that the (electricity) supply of electricity is sufficient to ensure the normal operation of the equipment/process. The idea of the quality of power is sometimes confused and rendered clearer. However, determining power consumption is becoming very relevant in today's complex electronic equipment. Both aspects of electrical control became confused by the extensive usage of high-tech equipment. Not only are such tools more sensitive to the effects of energy supply but they do have a detrimental effect. Poor quality of power can lead to lower productivity, data loss, and damage, damage to hardware, and energy inefficiency. "Power Quality" is a broad attempt to analyze electrical energy performance.

The causes and solutions of power quality problems are site-dependent, so the power quality assessment is important for sensitive projects. Under normal (ideal sinusoidal, balanced, and symmetric) conditions power quality is a loading problem. But the growth in the power electronics and control systems industry, the once majority linear customer loads, are now being dominated by a majority of non-linear customer loads. Such loads like switch-mode power supplies used in both industrial and commercial computers/microprocessors; variable speed drives used in process control; arcing devices like welders and arc furnaces; silicon controlled rectifiers used in air-conditioners; and any electronic device which draws current in pulses are termed to be non-linear. So the power quality of a system is equally the customer's concern as much it is the supply authority's concern.

Assessing the efficiency of electricity has been a core concern for nearly all electricity firms across the world. This is primarily attributed to the growing vulnerability of client systems which are now interconnected in extended networks which processes. As a result, power quality changes that have never been an issue can now be very expensive in terms of the types of process stops and equipment failures.

B. Types of PQ issues

The initial PQ test setup is for the analysis of its capabilities. PQ spreads may generally be characterized as transient voltage, long and short AC periods, current and voltage mismatch due to frequency change, AC and voltage AC, and disruption of the pf. Hence, specific voltages, waves, and eruptions are hard to handle. Hence this study mostly helps the most regular eruptions. Today more than ever, mobile gadgets and computational systems are used in various manufacturing processes. It is important to make such processes more effective, safe, and reliable. The main approach to reduce the PQ problem is to implement a proper wiring and grounding system for the electrical consumer's system.

The key approach to minimize PQ issues is to incorporate adequate electrical network cabling and grounding systems. To prevent the key issues created by PQ, it is important to develop a technological understanding of the electrical system. Electronic devices, especially applications for nonlinear charging, can also cause problems with the quality of service. Nonlinear loads consume harmonic currents, such that a harmonic voltage is produced as long as the harmonic current reaches the device impedance. The presence of harmonics causes electrical devices and electronic appliances in several issues. Another aspect that can increase the efficiency of energy is information regarding PQ.

A device that is ideal for electrical power line applications should be really helpful to boost PQ. The theoretical conduct history and the effect of using electrical charges in electrical systems are significant. The charging behavior depends on the thickness of the device's cord, the correct damping strategy, and the safety method. Please notice that loading affects most PQ-problems. The effect of natural factors, such as storms, animals, and human diseases, is another issue with achieving high PQ rates. The machine can't stop complications of these kinds. To prevent this issue on a wide scale, an effective security mechanism needs to be created.

This effect, however, also makes the production process and equipment more susceptible to factors requiring real power. Power efficiency refers to power source disturbances, including sudden interruptions, voltage drops, transients, harmonic disturbance, electrical disruption, and flickering lamps. The electrical grid is designed to produce power efficiently, that is to say, to increase customer energy supply. Nevertheless, accidents involving power consumption remain largely untracked, and as a result will knock out a period of up to 20-30 times a year, costing millions of dollars to industrial clients [7]. Industrial customers need to consider how power output impacts their network and how its impact can be mitigated to reduce those costs. Some of the main problems regarding power-efficiency are discussed below:

1) Voltage Interruption

The decrease in pure sine wave RMS is less than 0.2 per unit. Typically, it occurs when the voltage decrease occurs. Large faults exist mainly due to insufficient communication. The disturbance was the product of the circuit breakers lose contact, extreme fault, and reclosing. Transient events accompanied by an intrusion may be found for the enclosure of the circuit breaker operation.

2) Voltage Sag

It is called the in a decline of the initial voltage RMS between 0.1p.u.-0.90p.u. In a brief period of less than a few seconds, there is a loss in voltage outside of usual resistance. The explanation behind this voltage sag is mostly due to SLG failure, engine start or heavy load applied. In other words, it may be represented as a lesser voltage decrement period. The general term for sagging tension is also called the short-term reduction in tension. If the voltage drop is greater than 1 minute, the term "under-voltage" is used. Generally, voltage dips are divided into three categories according to the duration of the event. These classes are instantaneous, instantaneous, and temporary.

Solutions to voltage sag problems include equipment such as transformer, energy storage technologies, uninterruptible power supply (UPS), and dynamic voltage restorer (DVR).

3) Voltage Swell

These are RMS pure sine wave voltages that increase from 1.2 to 1.9. Compared with the voltage Sag, the frequency of voltage swells is very low. The time of the two is the same, that is, the time interval is between 0.3 and 1 minute. The reasons for this interruption are an incorrect motor start-up, load removal, symmetrical faults, transformer socket configuration, etc. Installing snap-action tap-changers in the system can reduce voltage expansion. Failure and shutting down heavy electrical equipment can cause the voltage to rise. The energy added by tension expansion usually overheats the equipment and shortens its service life. Voltage regulators, generators and uninterruptible power supplies can reduce the voltage expansion effect.

4) Harmonics

Harmonics can be described as a sine wave that provides voltage. The main causes of harmonics are irregular loads and system characteristics. The level of harmonic distortion is described by the full harmonic spectrum of the amplitude and phase angle of each harmonic component. Usually, a single total harmonic distortion (THD) quantity is also used as a measure of the actual value of harmonic distortion. Usually, a single total harmonic distortion (THD) quantity is also used as a measure of the actual value of harmonic distortion. One of the main problems related to harmonic interference is harmonic resonance. Resonance amplifies harmonic distortion to the extent that it may damage the device or cause the device to malfunction. Power factor correction capacitors in power distribution systems are the main cause of harmonic resonance. Other effects of harmonics are overloading of equipment, increased loss, and sometimes even equipment failure.

Interharmonics are voltages or currents which are not integer multiples of the fundamental frequency. They can be seen as discrete or broadband spectrum frequencies. One of the Harmonics activates is the cyclic converter. Note that the time-varying harmonic instruments may be recorded as interharmonics due to power quality limitations. There was no established a technologically sound system for accurate recording of harmonics. It is unclear what impact reciprocal harmonics have. They have been shown to affect the signaling of carriers on power lines.

5) Transients

A transient is a disturbance signal which dies to zero in a finite time. Transients will once again be classified as temporary Impulsive and temporary Oscillatory. Impulsive transients are a sharp, non-control frequency shift in the control signal's steady-state position, which is usually unidirectional in polarity, while oscillatory transients are a sharp frequency change in the power signal's steady-state situation, typically affecting both positive and negative polarity values.

Oscillation transients are another form of PQ phenomenon which is completely different from the three previous phenomena. Transients are sudden, abrupt shifts in the amplitude of the voltage. This interruption usually persists about 5 micro sec and 50 milliseconds. The transient amplitude can come to 2.0 per unit. Yet the most common oscillation transient amplitudes are 1.2 to 1.5 per unit. The frequency output level can be less than 5 kHz to 5 Mega Hz. In a discrete incident, the immediate amplitude shift may be either positive or negative. Transients can come from switching capacitors, reclosing circuit breakers, and switching loads.

Another transient impulse is another transient disturbance already experienced by electric users. Impulsive transients are sudden frequency changes rather than electric ones. Positive unidirectional polarity is the latent voltage shift of the pulse moving. This disruption is marked by their periods of rising and decline. The interruption length can be less than 50 nanoseconds and greater than 1 millisecond. The feature to remember in terms of increasing time is the spectral output. The pulse transient spectral value varies between 5 n-s and 0.1 m-s raise duration. The lighting is a natural source of pulse transients.

6) Voltage Spike and Surge

It is a brief period of changes in voltage from microsecond to millisecond; it happens due to lighting, extreme load switching, and power network faults. It triggers lock-up of system hardware malfunction, network theft, and data loss. Solutions to voltage spikes and problems with surges include an isolation transformer, such as surge arresters, filters.

7) Voltage Unbalance

It may be determined by the maximum variation from the average of the three-phase voltage, separated by the average of the three-phase voltage and expressed in percentage points. Symmetrical components can also be used to define the imbalances. To specify the percent imbalance, the ratio of either the negative or zero sequence components to the positive sequence component may be used. The primary source of voltage imbalance (usually less than 2 percent) is the unequal distribution of single-phase charges in a tri-phase condenser bank. Single-phase situations may result in a significant voltage imbalance (greater than 5 percent). An unbalance in voltage causes overheating of motors and transformers. This is because of the current imbalance in an induction device.

8) Voltage Fluctuations (Flicker)

These are periodic changes in the RMS voltage value or a series of random voltage changes whose amplitude usually does not exceed the voltage range of 0.9 per unit. The common voltage fluctuation phenomena in 1.1 per unit voltage flicker. The charge will show a continuous and rapid change in the magnitude of the charging current, which may cause voltage fluctuation or flicker. Current industrial practice is to characterize the severity of nervous flicker regarding the sensitivity of human visual perception. Electric arc furnaces and welding machines are the most common causes of voltage fluctuations in utility transmission and distribution systems. Other sources of voltage fluctuations include sawmills, draglines, and rock crushers. Voltage fluctuations can be regarded as repeated random dips and dips. It can be evaluated using a steady-state power system model. A rugged power system can greatly reduce the severity of voltage fluctuations. Fluctuations in voltage can quickly cause incandescent and fluorescent lights to flicker.

It may also cause malfunction of sensitive equipment. The static VAR system can reduce the flicker effect [14].

9) Variations of Power Frequency

Such are the variations between the electrical system 's fundamental frequency and its usual value. The grid frequency is directly related to the generator speed which is supplying the grid. As the load-output dynamic equilibrium shifts, the frequency will shift marginally. The magnitude and duration of the frequency deviation depend on the characteristics of the load and the response to changes in load from the power generation control system. Large frequency changes are rare in modern electrical systems that are interconnected. The resulting frequency shifts are more likely to arise for loads generated by generators disconnected from the delivery grid. [15].

10) Notch

This is a periodic voltage disturbance induced by the regular functioning of electrical control systems as the current is transferred from one step to the next. Notching may be defined by the affected voltage's harmonic spectrum. While notching is a special case of voltage harmonic, it is generally treated as an independent disturbance. The frequency components involved with notching may be very large, so the instruments usually used for harmonic analysis cannot be readily calculated.

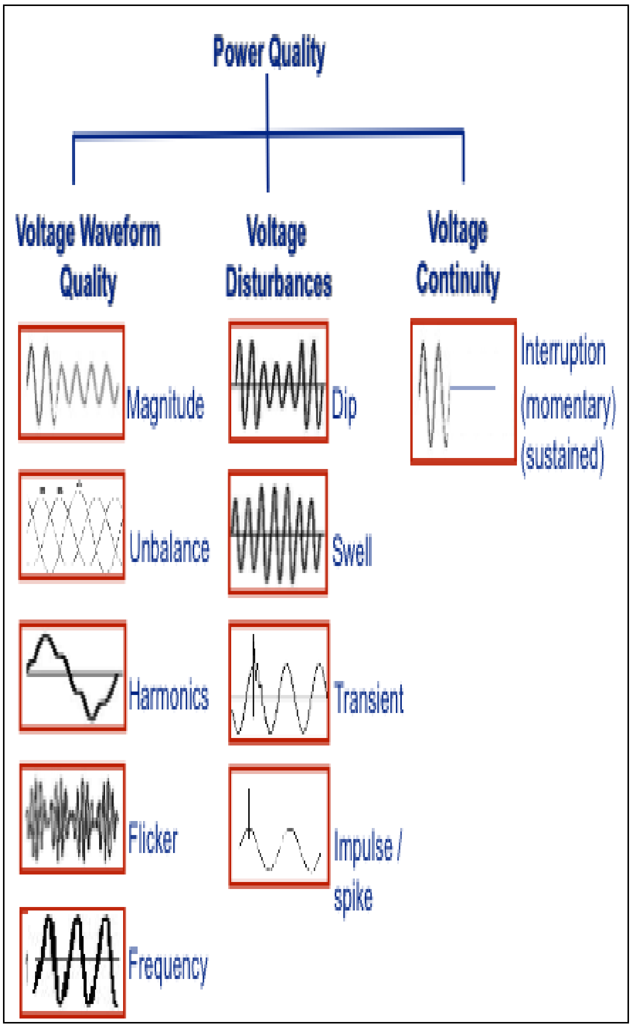

Fig.1 PQ issues and its waveforms

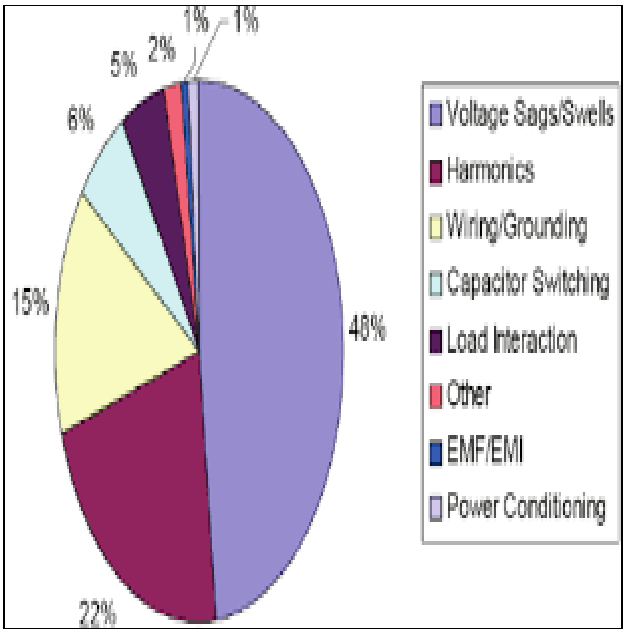

Fig.2 Pie chart of PQ issue

III. MODELLING APPROACH

Models are generated using MATLAB/SIMULINK for simulations. It is used to model different power quality supply disruptions, and to evaluate how such disruptions affect the transmission system's sine wave.

Simulation models listed below involve voltage drop line failure reducing broad voltage swell load (nonlinear load) and voltage transient models used to simulate various disturbances of power quality.

Table-I Specification of Line Fault Model

Specification of Line Fault Model			
Parameters	***Rating of Voltage Sag***	***Rating of Voltage Swell***	***Rating of Transient***
Source Feeder	11KV 30 MVA	132KV	11KV 30 MVA
Bus Bar	11KV/0.4KV	220KV	11KV
Transformer	11KV/0.4KV 1MVA	132KV/220 KV,100MVA	11KV, 1MVA
Frequency	50Hz	50Hz	50Hz
Resistive Load	10KW	10KW	10KW
Inductive Load	100VAR	800MVA	100VAR
Breaker	-	220KV	-

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A. Line fault model for voltage sag

In power quality studies the magnitude of the voltage sag waveform is usually described in RMS waveform and standardized for better visualization. Figure 1 shows the RMS study of the sag waveforms for line-to-line fault voltage. For each phase, the magnitudes of the sag may be visualized. The slight oscillation occurs at pre- and post-sag, and the phase shift[8] during the fault induces the swell. Able to replicate multi-stage line errors in the groups, the model often fails. Voltage drops (also known as "sags") reflect a voltage drop of 10 percent or more below standard or suggested use, such as a 120 voltage outlet that drops to 90 volts.

With several appliances, voltage changes may have a rippling effect, such as utilizing a hairdryer in one room that allows the lights to dim in another. This will result from turning large engines on to temporary short circuits in the power lines of utilities. Under voltage is a dip that lasts longer than one minute, and may result from overloaded transformers or undersized conductors. The multi-stage voltage sag is usually attributable to several fault protection relay clearance systems that are not synchronous with each other, thereby altering power device impedance and network layout contributing to several phases of voltage decay until completely returning to its nominal level or adjustments in fault or ground impedance during the fault.

The simulation model in fig.3 consists of 50Hz 11KV 30MVA three-phase source block feeding into an 11KV/0.4KV 1MVA star/delta converter to a load resistance of 10KW and 100VAR inductive. Instant waveform and measuring RMS scopes are located at 11KV buses and 0.4 KV buses. The 11KV bus has two fault blocks to represent line fault and multistage fault.

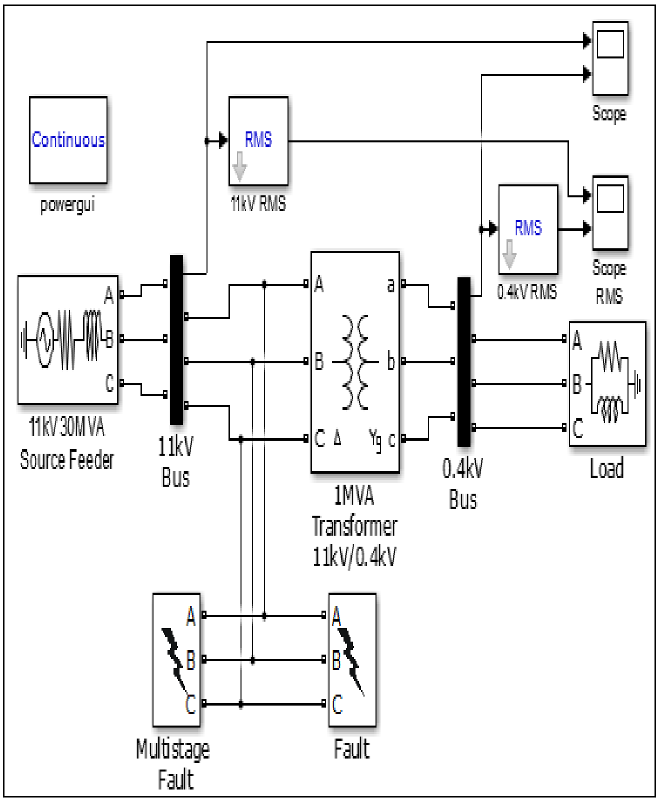

Fig.3 Simulation model of Line fault for voltage sag

B. Simulation model of Line Fault for Voltage Swell

Voltage swells are the reverse of a sag, characterizing voltage surges 10% or greater than usual or implied application. They can cause problems with the machinery and overall power quality in installation. Swells can occur when a heavy load (such as a large motor) is turned off and the voltage of the power line decreases for a short period. Overvoltage is a swell that lasts more than a minute, sometimes caused where charges are near to the edge of a power delivery device, where taps are improperly set on a transformer, or where alternative energy sources, such as solar panels, are attached to the network. The problem with voltage swell involves charging condenser banks, the shutdown of heavy loads, unbalanced spikes of fault, transients, and power level. The built-in MATLAB simulation of a three-phase heavy load shutdown model is shown in fig.4.

The large model of shutdown load is used to describe the voltage swell caused by removing a heavy charge. The broad load shutdown configuration consists of a 50 Hz 132KV tri-phase source block feeding to a resistive inductive load at 800MVA via a 132KV/220KV 100MVA star/delta transformer. There is a three-phase external charge shutdown creating voltage swelling at 220KV buses when a 3-phase breaker is triggered at the 220KV feeder side.

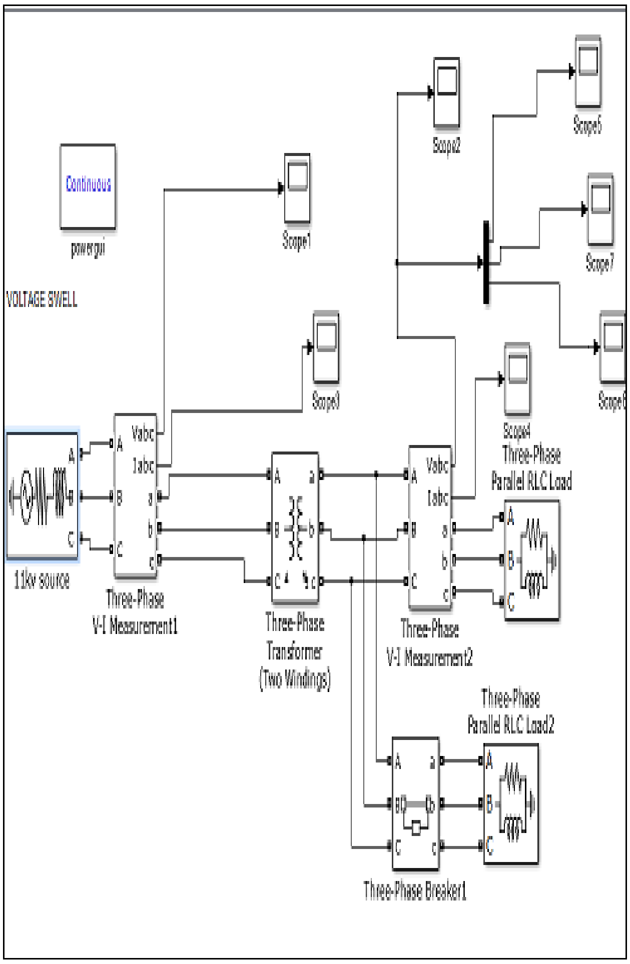

Fig.4 Simulation of Line Fault Model for Voltage Swell

C. Simulation model of Line Fault for Transient

Voltage Transients are described as short-lived bursts of electrical energy that arise from a rapid release of energy already accumulated or otherwise caused, such as heavy inductive charges or lightning. This energy may be predictably produced inside electrical or electronic circuits by controlled switching activity or added into a circuit randomly through third-party sources. Repeatable transients are often triggered by the operation of motors, engines, or sensitive circuit part changes. Lightning and Electrostatic Discharge are generally uncertain and may require careful monitoring to be accurately measured, particularly when induced at the level of the circuit board. Numerous groups of electronics standards measured transient tension events using approved methods with monitoring or control. Fig.5 consists of 11KV, 30MVA, 50Hz three-phase source feeding to a 10KW resistive, and 100VAR inductive load via 1MVA star/delta transformer.

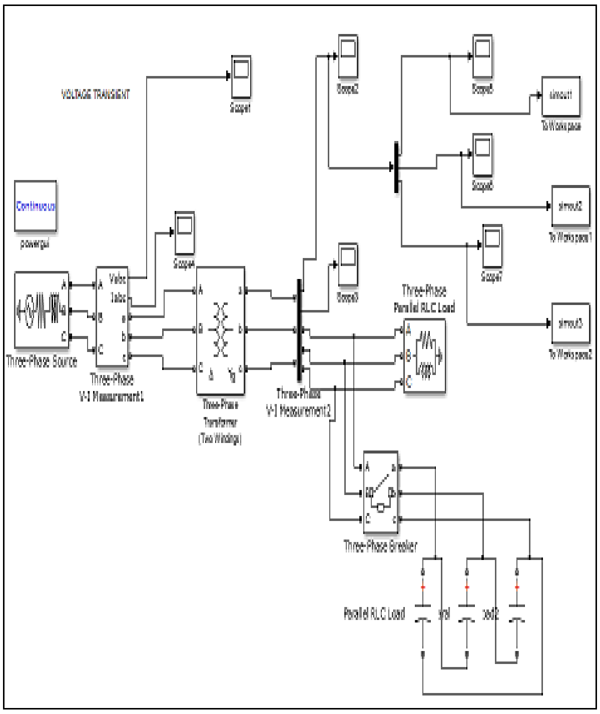

Fig.5 Simulation model of transient voltage

IV. RESULTS AND DISCUSSION

The simulation model defined multiple faults which occur continuously in a short time and are reported as one occurrence within a single record. Fig.5&6 shows instantaneous waveforms caused by the failure of a double line to a multi-stage voltage decay of the ground.

The fault block is set to simulate failure with 1 0.1 to 0.168-second impedance defect, and the multi-stage defect block is set to simulate failures with 0.168 to 0.3-second impedance defect 0.1 The changes in fault impedance during a fault result in a disturbance of the output of the multi-stage voltage sag control.

Fig.6 and Fig.7 display the simulation result of the multi-stage voltage drop waveform at 11 kV due to the double LG fault and 0.4kv line.

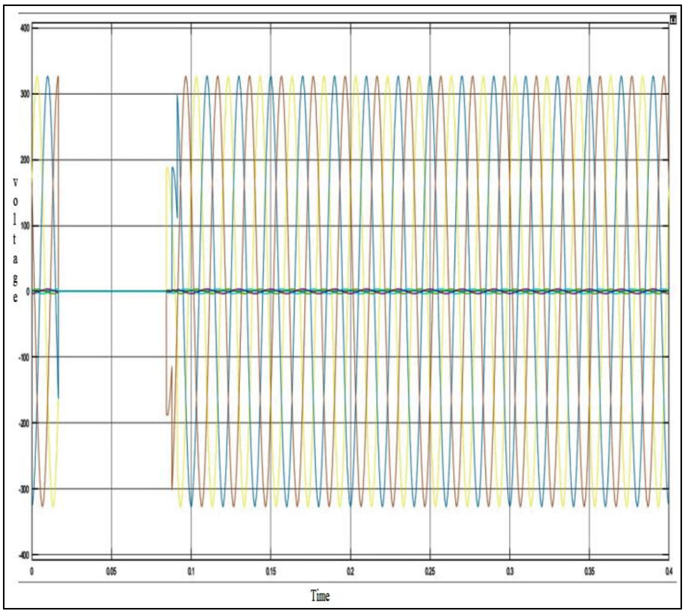

Fig.6 Voltage sag waveform

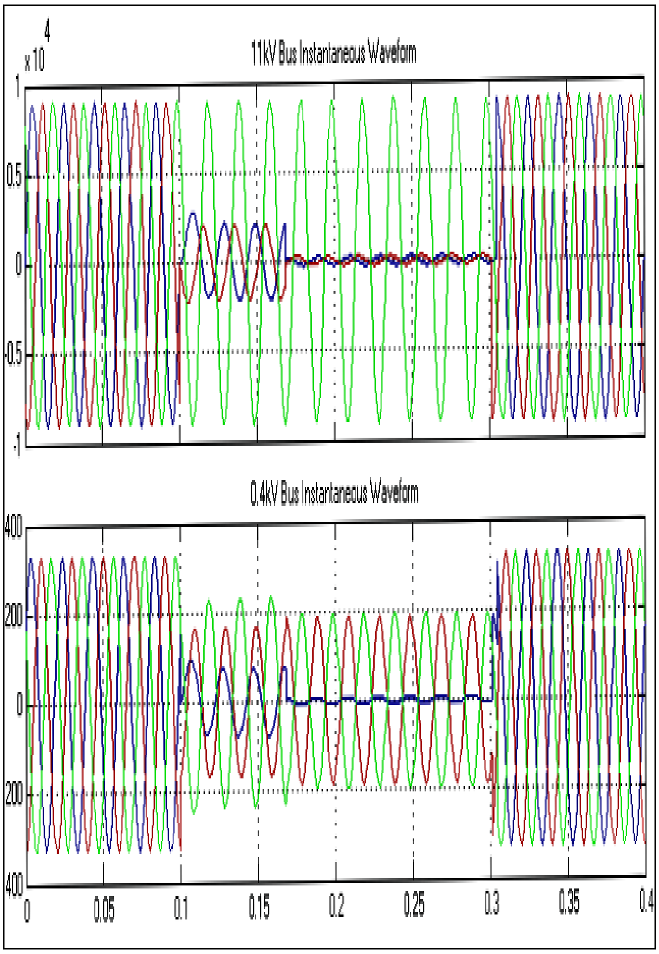

Fig.7 Voltage sag waveform caused by Line fault at 11 KV and 0.4KV line.

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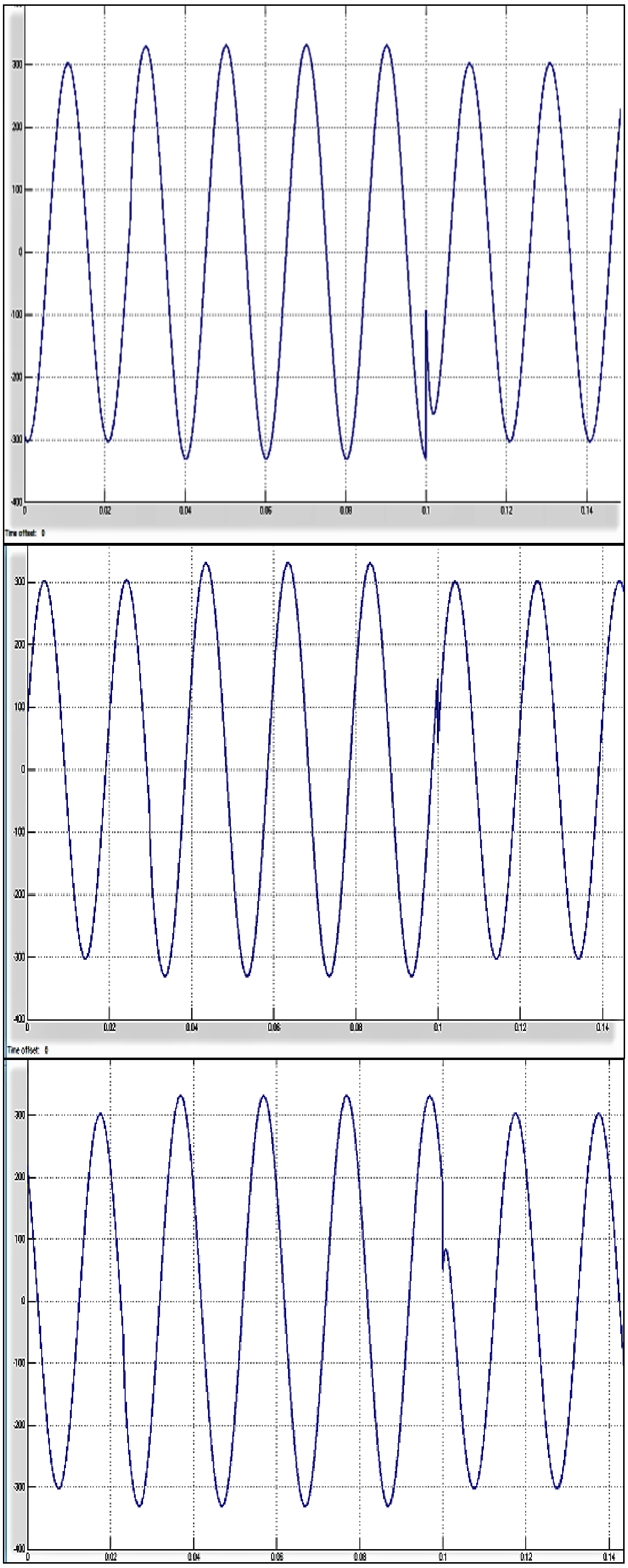

Fig.8 Simulation results of a Voltage Swell

Fig.8 shows RMS voltage increased to 110 percent-180 percent nominal, at power frequency for 1⁄2 period to 1-minute duration.

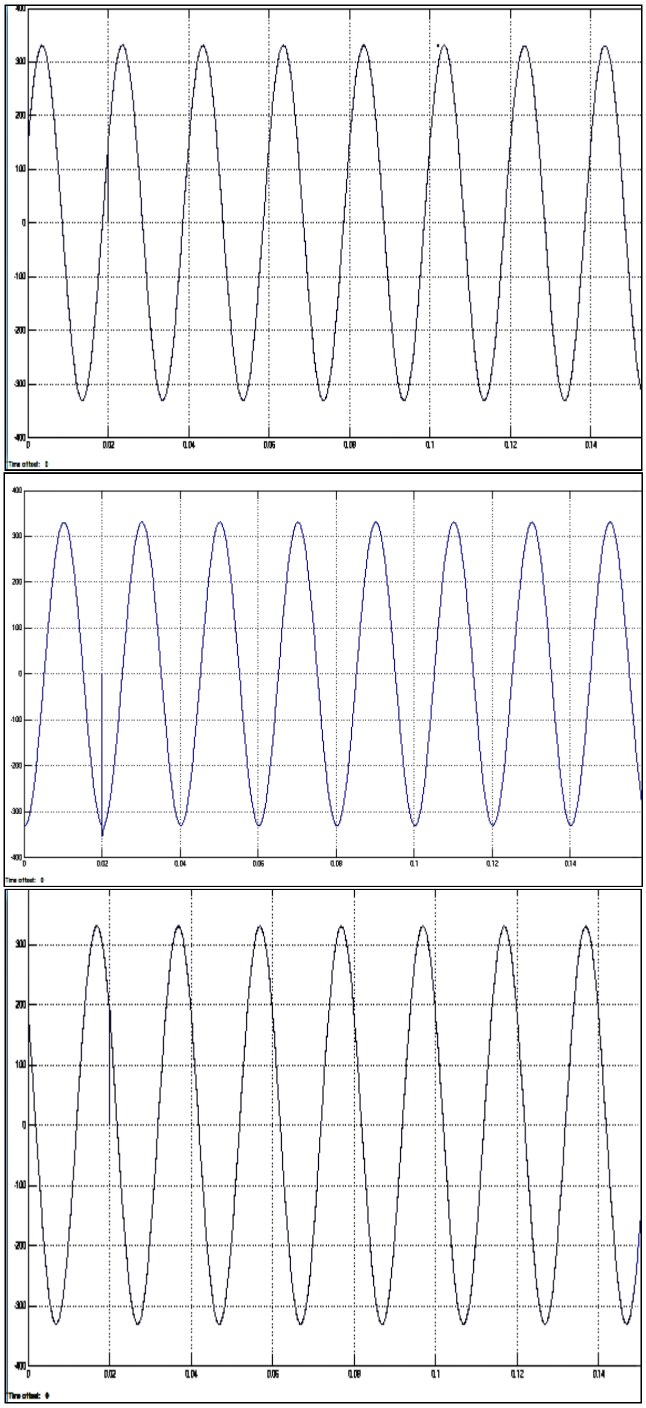

Fig.9 Simulation results of Transient Voltage

Fig.9 shows transients are a sudden change in voltage or current magnitude in between 4.5micro-second to 50milli-second where magnitude will drop to 1.9 per unit.

V. CONCLUSION

These simulations provide flexibility in the creation of models of power systems that simulate disturbance of power quality by connecting particular work blocks in the simulation environment. These models give insight into how power quality disruption, propagation, and function within the context of the simulated power system.

The downside of the simulation method is its dependence on the functionality of the selected software, basic knowledge of energy efficiency and simulation software, and the supply of transmission line components needed to build the power system model to simulate the expected disturbance of the power quality. Due to fault, voltage swell, transient, harmonic, like voltage sag, these simulation model designs represent power quality disturbances. Such models have simple frameworks for both power quality analysis and power quality performance analysis. The presented work offers a summary of generating energy. Related problems were discussed and clarified concerning PQ. The paper also addresses another issue relating to the definition of disturbances to power quality. Loss in output is typically more expensive than the physical impact on the device that results from malfunction, mistake, and down in computer equipment.

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