DETECTION OF POWERGRID SYNCHRONISATION FAILURE ON SENSING FREQUENCY AND VOLTAGE BEYOND ACCEPTABLE RANGE

PROJECT REPORT

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BACHELOR OF TECHNOLOGY

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

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CERTIFICATE

This is to certify that the project entitled "**DETECTION OF POWER GRID SYNCHRONISATION FAILURE ON SENSING FREQUENCY AND VOLTAGE BEYOND ACCEPTABLE RANGE"** is a bonafied work carried out under supervision in the **Department of Electrical and electronics Engineering**, **Sri Venkateswara University College of Engineering.**

The work is comprehensive, complete and fit for evaluation carried out in partial fulfilment of the requirements for the award of **Bachelor of Technology** in **Electrical and Electronics Engineering** during the academic year 2021-22.

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DECLARATION

We declare that the project entitled **"DETECTION OF POWER GRID SYNCHRONISATION FAILURE ON SENSING FREQUENCY AND VOLTAGE BEYOND ACCEPTABLE RANGE"** is a bonafied work carried by me in partial fulfilment of requirement for the award of the degree of BACHELOR OF TECHNOLOGY during the academic year 2021-2022. To the best of our knowledge this work has been not submitted elsewhere for the award of any degree.

SIGNATURE :

ACKNOWLEDGMENT

I would like to express my profound gratitude to my esteemed guide and **Head of the Department** **Dr. GOWRI MANOHAR** professor, Department of Electrical and Electronics Engineering, Sri Venkateswara University college of engineering Tirupati, for this valuable advice and inspiring guidance for successful completion of this work

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As a gesture of respect for our family members and support we receive from them and we dedicate this work to them.

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ABSTRACT

This main objective of this project is to build a simulation model of a system in Matlab and Simulink software which monitors voltage and provides a break point by low and high voltage tripping mechanism that keep away from any damage to the load, majority of industrial and domestic systems would encounter fluctuation in the AC mains supply. The chance of damaging electronic devices is very large

The project is designed to develop a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage. There are several power generation units connected to the grid such as hydel, thermal, solar etc. to supply power to the load. These generating units need to supply power according to the rules of the grid.

As per **CENTRAL ELECTRICTY AUTHORITY OF INDIA** Regulations 2010, variation of the system voltage should be of +- 5 % and make all efforts to operate at a frequency close to 50 Hz and shall not allow it to go beyond the range 49.2 to 50.3 Hz. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding [**From reference 1**] This prevents in large scale brown out or black out of the grid power. So, it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure.

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CHAPTER 1

INTRODUCTION

1.INTRODUCTON

In India we have five national grids, Western grid, Eastern grid, North-East grid, Southern grid, Northern grid. Northern grid, Eastern grid, North-East grid, Western grid are synchronized with each other and southern grid is asynchronized. The modern society is so much dependent upon the use of electrical energy that it has become a part and parcel of our life. Several new trends have already employed in the electricity infrastructure. It includes the expansion of the existing grid with micro grids and mega grids, extensive sensors, data processing, visualization tools, etc.

Synchronization means the minimization of difference in voltage, frequency and phase angle between the corresponding phases of the generator output and grid supply. An alternating current generator must be synchronized with the grid prior to connection. It can’t deliver the power unless it is running at same frequency as the network. Synchronization must occur before connecting the generator to a grid. Synchronization can be achieved manually or automatically. The purpose of synchronization is to monitor, access, enable, and automatically take the control action to prevent the abnormalities of voltage and frequency.

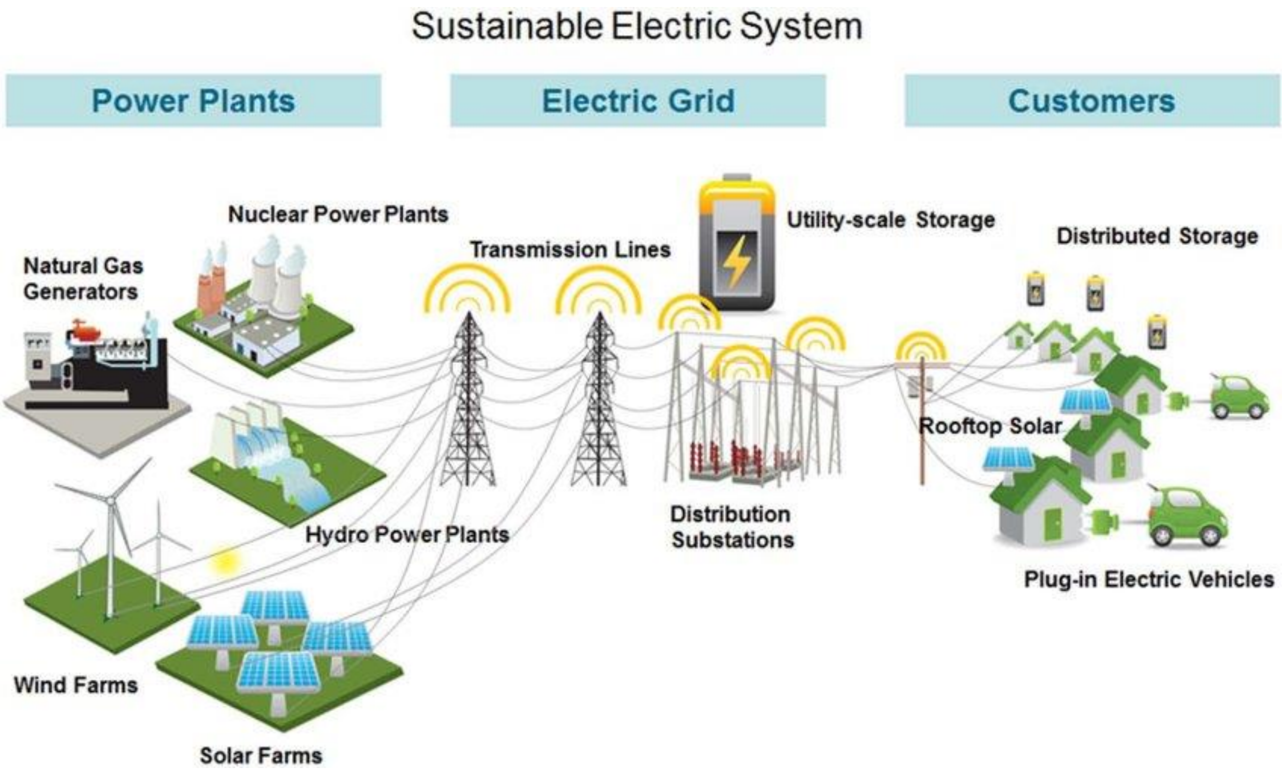
The power will only transfer from one bus to another bus, when two frequencies of that voltage and currents are same.

For synchronization of all power generating station with State as well as National power grid we have selected three parameters voltage, frequency and phase angle between voltage and current if any of these parameters is violated due to any abnormality or fault the power station will not be able to fulfil all the three conditions for synchronizations so it will get a synchronized with grid and it’s called situation of ISLANDING.

Islanding state occurs when one or many sources continue to feed power to a part of the grid that is disconnected from the main utility. Islanding situations can damage the grid itself or equipments connected to the grid and can even compromise the security of the maintenance personnel that service the grid. Therefore, according to IEEE1547 standard, islanding state should be identified and disconnected in 2 seconds. There are quite a few different methods used to detect islanding.

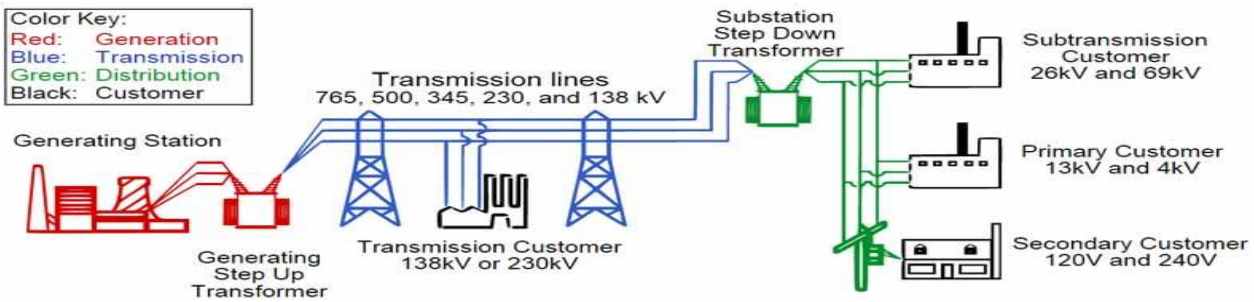
1.1 POWER GRID

- A power grid is an interconnected network of transmission lines for supplying electricity from power suppliers to consumers. Any disruptions in the network causes power outages. India has five regional grids that carry electricity from power plants to respective states in the country.
- Electric power is normally generated at 11-25kV and then stepped-up to 400kV, 220kV or 132kV for high voltage lines through long distances and deliver the power into a common power pool called the grid.
- The grid is connected to load centres (cities) through a sub transmission network of normally 33kV lines which terminate into a 33kV (or 66kV) substation, where the voltage is stepped-down to 11kV for power distribution through a distribution network at 11kV and lower.
- The 3 distinct operations of a power grid are: -
  1. Power generation
  2. Power transmission
  3. Power distribution.



Operations of Power grids

- Electricity generation - Generating plants are located near a source of water, and away from heavily populated areas, are large and electric power generated is stepped up to a higher voltage-at which it connects to the transmission network.
- Electric power transmission - The transmission network will move the power long distances–often across state lines, and sometimes across international boundaries, until it reaches its wholesale customer.
- Electricity distribution - Upon arrival at the substation, the power will be stepped down in voltage—to a distribution level voltage. As it exits the substation, it enters the distribution wiring. Finally, upon arrival at the service location, the power is stepped down again from the distribution voltage to the required service voltage.



1.2 STRUCTURE OF POWER GRID

- The structure or "topology" of a grid depends upon the geology of the land available. The other constraints are of budget, requirements for system reliability, the load and generation characteristics.
- The cheapest and simplest topology for a distribution or transmission grid is a radial structure i.e., a tree shape where power from a large supply radiates out into progressively LV lines until destination is reached.
- The power network, is the distribution network of 11kV lines or feeders (that carry power close to the load points) downstream of the 33kV substation.
- At these load points, a transformer further reduces the voltage from 11kV to 415V (LT feeders) to individual customers, either at 220V (as 1-phase) or at 415V (as 3-phase).
- A feeder could be either an overhead line or an underground cable. In urban areas, owing to the density of customers, the length of an 11kV feeder is up to 3 km, while in rural areas it is up to 20 km.
- Most transmission grids require the reliability of mesh networks however the expense of mesh topologies restricts their application to transmission and medium voltage distribution grids.
- Redundancy allows line failures to occur and power is simply rerouted while workmen repair the damaged and deactivated line.
- Types of transmission lines: -

  1. Overhead transmission lines
  2. Underground transmission lines

Need for power grids

- Electric-power transmission is the bulk transfer of electrical energy, from generating power plants to electrical substations located near demand centres and it is different from the local wiring between hv substations and customers (which is typically referred to as electric power distribution).
- A key limitation in the distribution of electric power is that, electrical energy cannot be stored, and therefore must be generated as per the requirement. Hence a sophisticated control system is required to ensure that the electric generation matches the demand.
- If the demand for power exceeds the supply, generation plants and transmission equipment can shut down which, in the worst cases, can lead to a major regional blackout, such as occurred in the July 2012 in India.
- **Reliability:** Since the grid is an enormous network, electricity can be deployed to the right places across large regions of the country. The large transmission network allows grid operators to deal with anticipated and unanticipated losses, while still meeting electricity demand.
- **Flexibility:** The electricity grid allows a power system to use a diversity of resources, even if they are located far away from where the power is needed. For example, wind turbines must be built where the wind is the strongest; the grid allows for this electricity to be transmitted to distant cities.
- **Economic competition:** Because the grid allows multiple generators and power plants to provide electricity to consumers, different generators compete with each other to provide electricity at the cheapest price. The grid also serves as a form of insurance – competition on the grid protects customers against fluctuations in fuel prices.

- A historic blackout in 2003 showcased why effective grid transmission is so important. On August 14, 2003, an Ohio power company set off the largest blackout in human history simply due to human error [13]. The blackout spread across New York, Pennsylvania, Connecticut, Massachusetts, New Jersey, Michigan, and even parts of Canada. Offices had to be evacuated, and thousands of people flooded hospitals suffering from the heat [14]. Our electricity grid has come a long way since 2003, but many more opportunities exist for improvement.

NEW OPPORTUNITIES ON THE GRID

The electricity grid is a dynamic system. It has changed and evolved rapidly over the last century to accommodate new technologies, increases in electricity demand, and a growing need for reliable, diverse sources of electricity. Even on an hourly basis, the grid is changing, with different sources of electricity being manipulated to satisfy demand at the least cost.

As technology changes and better options become available, significant improvements could be made to the electricity grid.

For example, energy storage technologies could allow electricity to be stored for use when demand for electricity peaks or increases rapidly, increasing efficiency and reliability. Newer, more advanced meters such as self-programming thermostats will allow better data collection for more effective management and faster response times. Even vehicles could play a role, as smart charging can allow electric cars to interface with the electric grid.

Distributed generation systems, such as solar panels on individual homes, reduce the distance that electricity has to travel, thereby increasing efficiency and saving money. Investments made by consumers – such as purchasing energy-efficient appliances, constructing more energy-efficient buildings, or installing solar panels – save customers money and utilize energy more efficiently at the same time.

1.3 POWER GRID FAILURE

- In India electricity is transmitted at a frequency of 49-50 Hz. When the frequency reaches its minimum or maximum level, there is a risk of failure of transmission lines.
- Thus, the breakdown of transmission lines due to over or under frequency is called Power Grid Failure.
- The role of Load Dispatch Centre's is to maintain the frequency between minimum 48.5 to maximum of 50.2 Hz. The National Load Dispatch Centre is also responsible for maintaining the Overdraw done by states.
- When the states overdraw power crossing their limits, the same also becomes the cause of grid failure, due to excessive load on the transmission lines.

Reasons for power grid failure

- In the summer of 2012, leading up to the failure, extreme heat had caused power use to reach record levels in New Delhi leading to coal shortages in the country. (As fossil fuels stocks are rationed by government and are imported offshore.)
- Due to the late arrival of monsoons, agricultural areas in Punjab and Haryana drew increased power from the grid (Farmers using energy intensive water pumps for irrigation)
- The late monsoon also meant that hydropower plants were generating less than their usual production and hence the load on thermal power plants increases to support the demand of load.
- Illegal utilization of electricity is also a major reason for power grid failure.

- India's basic energy shortage is compounded by the policy of selling electricity to consumers at politically correct prices i.e. sometimes cheap and even free to voters. Here the government-owned distribution monopolies have failed. This loss estimates up to 1% of gross domestic product in the country.

CHAPTER 2
POWER QUALITY

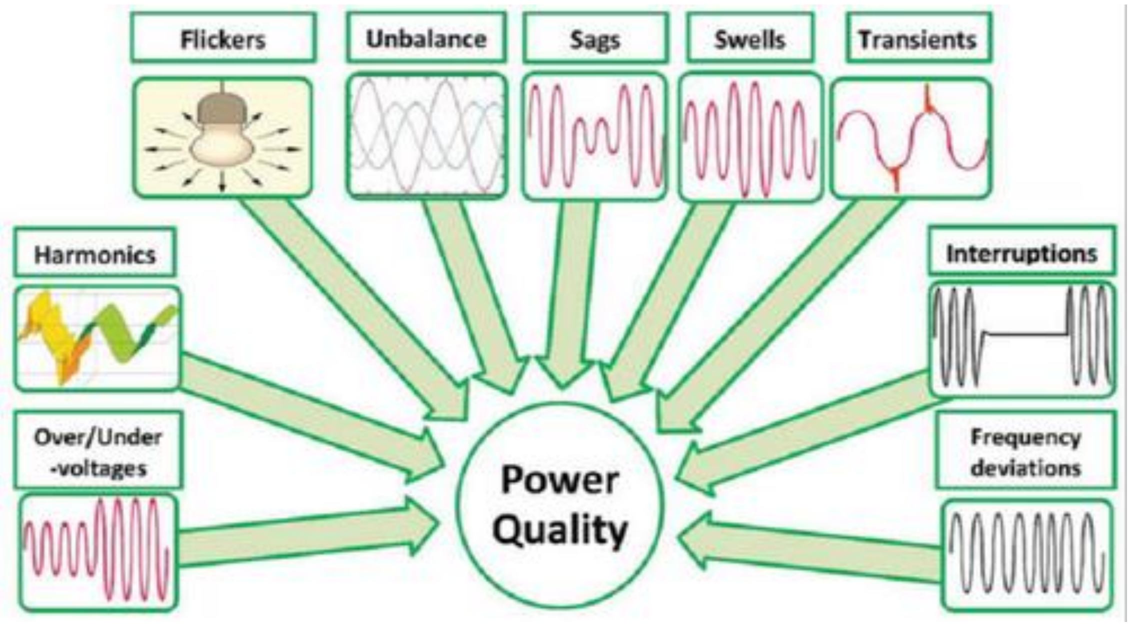
POWER QUALITY

2.1 INTRODUCTION :-

Power quality monitoring programs are often driven by the demand for improving the system wide power quality performance. Many industrial and commercial customers have equipment that is sensitive to power disturbances, and therefore, it is more important to understand the quality of power being provided…

Power quality determines electrical supply of constant magnitude and frequency – sinusoidal voltage waveform to consumer devices. Synchronisation of the voltage, frequency and phase allows electrical systems to function in their intended manner without significant loss of performance or life of consumer devices. The Power Quality of a system expresses to which degree a practical supply system resembles the ideal supply system. The term is used to describe electric power that drives an electrical load and the load's ability to function properly.

What is power quality?

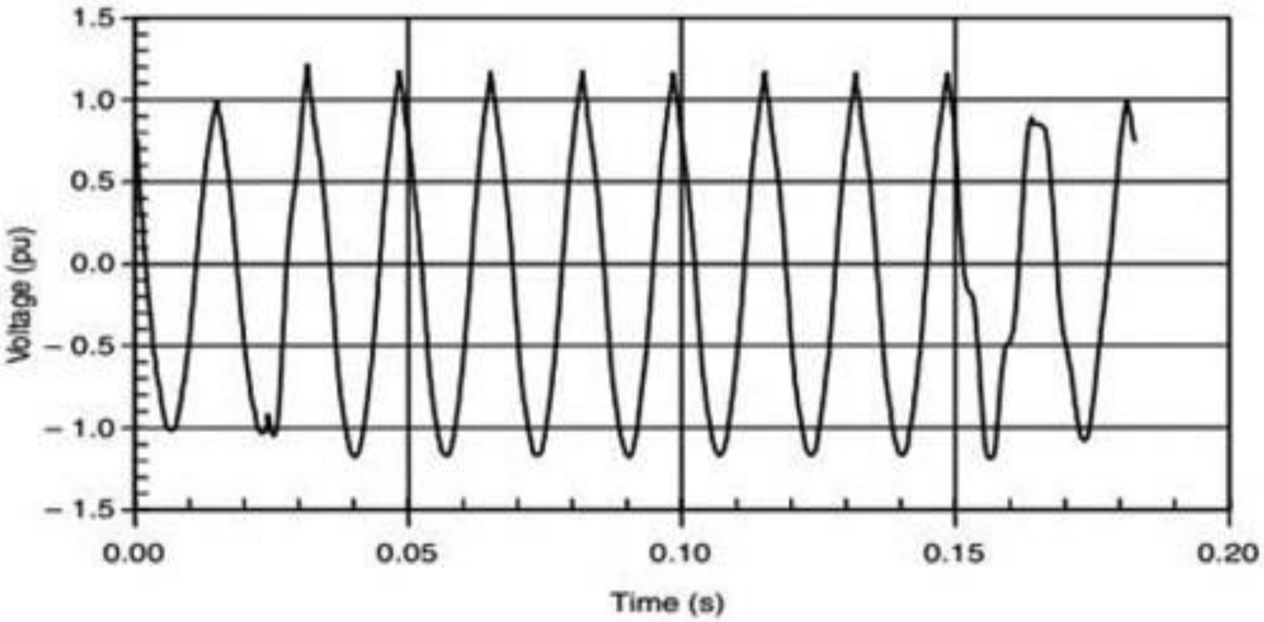


Power Quality = Voltage Quality
P = V I
V-Voltage-consistent controlled by power supply system
I- Current-varied by particular load

Therefore, the standards on the power quality are maintaining the supply voltage within certain limits. Any power problem manifested in voltage, current or frequency deviations results in failure or mis operation of customer equipment. However, it is actually the quality of the voltage that is being addressed in most cases.

Technically, in engineering terms, power is the rate of energy delivery and is proportional to the product of the voltage and current. It would be difficult to define the quality of this quantity in any meaningful manner. The power supply system can only control the quality of the voltage; it has no control over the currents that particular loads might draw. Therefore, the standards in the power quality area are devoted to maintaining the supply voltage within certain limits. AC power systems are designed to operate at a sinusoidal voltage of a given frequency (typically 50 or 60 Hz) and magnitude. Any significant deviation in the waveform magnitude, frequency, or purity is a potential power quality problem. Of course, there is always a close relationship between voltage and current in any practical power system. Although, the generators may provide a near-perfect sine-wave voltage, the current passing through the impedance of the system can cause a variety of disturbances to the voltage. For example:

- The current resulting from a short circuit causes the voltage to sag or disappear completely, as the case may be.
- Currents from lightning strokes passing through the power system cause high-impulse voltages that frequently flash over insulation and lead to other phenomena, such as short circuits.
- Distorted currents from harmonic-producing loads also distort the voltage as they pass through the system impedance. Thus, a distorted voltage is presented to other end users.



Instantaneous voltage swell caused by an SLG fault

Therefore, while it is the voltage with which we are ultimately concerned, we must also address phenomena in the current to understand the basis of many power quality problems.

2.2 CAUSES OF POWER QUALITY

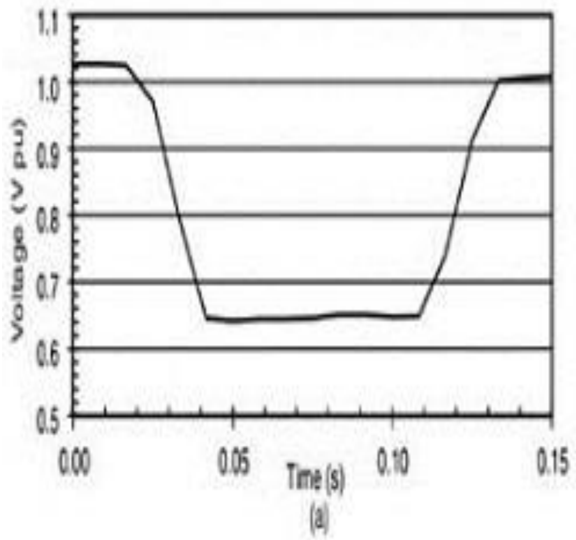
Why are we concerned about power quality?

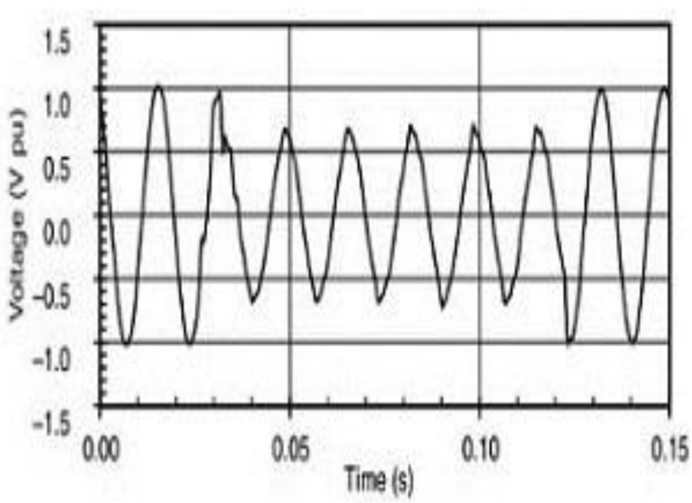
The ultimate reason that we are interested in power quality is economic value. There are economic impacts on utilities, their customers, and suppliers of load equipment. The quality of power can have a direct economic impact on many industrial consumers. Thus, like the blinking clock in residences, industrial customers are now more acutely aware of minor disturbances in the power system. There is big money associated with these disturbances.

Causes of poor power quality:

1.Variations in the peak or RMS(ROOT MEAN SQUARE) voltage.
2. **Swell:** When the RMS voltage exceeds the nominal voltage by 10 to 80% for 0.5 cycle to 1 minute, the event is called a 'swell.
3. **Dip/Sag:** The RMS voltage is below the nominal voltage by 10 to 90% for 0.5 cycle to 1 minute. Refer Figure 2.
4. **Flicker:** Random or repetitive variations in the RMS voltage between 90 and 110% of nominal can produce a phenomenon known as 'flicker' in lighting equipment. Flicker is rapidly visible changes of light level.
5. **Spikes/Impulses/Surges:** Abrupt, very brief increases in voltage, called 'spikes', 'impulses', or 'surges', generally caused by large inductive loads being turned off, or more severely by lightning.
6. **Undervoltage:** An undervoltage is a decrease in the RMS AC voltage to less than 90% at the power frequency for a duration longer than 1 min. The term 'brownout' is an apt description for voltage drops somewhere between full power (bright lights) and a blackout (no power – no light). A load switching on or a capacitor bank switching off can cause an undervoltage until voltage regulation equipment on the system can bring the voltage back to within tolerances.
7. **Overvoltage:** An overvoltage is an increase in the Rms AC voltage greater than 110% at the power frequency for a duration longer than 1

min. Overvoltages are usually the result of load switching (e.g., switching off a large load or energising a capacitor bank). The overvoltages result because either the system is too weak for the desired voltage regulation or voltage controls are inadequate. Incorrect tap settings on transformers can also result in system overvoltages.
8. **Power Frequency Variations:** Power frequency variations are defined as the deviation of the power system fundamental frequency from its specified nominal value (e.g., 50 Hz). The power system frequency is directly related to the rotational speed of the generators supplying the system. There are slight variations in frequency as the dynamic balance between load and generation changes. The size of the frequency shift and its duration depends on the load characteristics and the response of the generation control system to load changes.
9. **Waveform Distortion:** Waveform distortion is defined as a steady-state deviation from an ideal sine wave of power frequency principally characterised by the spectral content of the deviation. It is usually described as harmonics at lower frequencies (usually less than 3 kHz) and described as Common Mode Distortion or Interharmonics at higher frequencies. All these phenomena potentially lead to inefficient running of installations, system down time and reduced equipment life and consequently high installation running costs. If due to poor power quality the production is stopped, major costs are incurred.



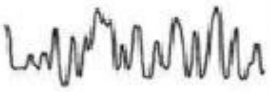
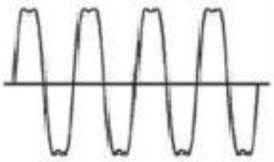


2.3 CORRECTION

Possible consequences of poor power quality

1.Equipment failure or malfunctioning.
2. Unexpected power supply failures (breakers tripping, fuses blowing).
3. Equipment overheating (transformers, induction motors etc.) leading to their lifetime reduction.
4. Increase of system losses.
5. Damage to sensitive equipment (Computers, control systems equipments etc).
6. Communication Interference in case of electronics devices.
7. Increases the need of oversize installations to cope with additional electrical stress, which leads to consequential increase of installation and running costs.
8. Poor power factor that leads to penalty or increases need and cost of installation of power factor correction equipments.

Table 1: Monitoring of different types of power quality parameters

Type of Power quality variation		Requirements for monitoring	Analysis and display requirements
Voltage regulation and unbalance		• Three-phase voltages • RMS Magnitudes • Continuous monitoring with periodic maximum minimum, and average samples • Currents for response of equipment	• Trending • Statistical evaluation of voltage levels and unbalance levels
Harmonic (distortion harmonics)		• Three-phase voltages and currents • Waveform characteristics • 128 samples per cycle minimum • Synchronized sampling of all voltages and currents • Configurable sampling characteristics	• Individual waveforms and FFTs • Trends of harmonic levels (THD and individual) • Statistical characteristics of harmonic levels • Evaluation of neutral conductor loading issues • Evaluation with respect to standards (e.g., IEEE 519, EN 50160) • Evaluation of trends to indicate equipment problems
Voltage sags, swells and short-duration interruptions		• Three-phase voltage and currents for each event that is captured • Configurable thresholds for triggering events • Characteristics of events with actual voltage and current waveforms, as well as rms vs. time plots • RMS resolution of 1 cycle or better during the rms vs. time events and for triggering	• Waveform plots and rms vs. time plots with pre- and post event information included • Evaluation of cause of each event (fault upline or downline from the monitoring) • Voltages and current to evaluate load interaction issues • Magnitude duration plots superimposed with equipment ride-through characteristics (e.g., ITI curve or SEMI curve) • Statistical summary of performance (e.g., bar charts) for benchmarking • Evaluation of power conditioning equipment performance during events
Transients		• Three-phase voltages and currents with complete waveforms • Minimum of 128 samples per cycle for events from the power supply system (e.g., capacitor switching) • Configurable thresholds for triggering • Triggering based on waveform variations, not just peak voltage	• Waveform plots • Evaluation of event causes (e.g., capacitor switching upline or downline from monitor) • Correlation of events with switching operations • Statistical summaries of transient performance for benchmarking

Power Quality Monitoring

Power quality monitoring is the process of gathering, analysing, and interpreting raw measurement data into useful information. The process of gathering data is usually carried out by continuous measurement of voltage and current over an extended period. The process of analysis and interpretation has been traditionally performed manually, but recent advances in signal processing and artificial intelligence fields have made it possible to design and implement intelligent systems to automatically analyse and interpret raw data into useful information with minimum human intervention.

Power quality monitoring programs are often driven by the demand for improving the system wide power quality performance. Many industrial and commercial customers have equipment that is sensitive to power disturbances, and therefore, it is more important to understand the quality of power being provided.

Different types of instruments are used to monitor the power quality parameters like CT, VT, Transducers, digital meters, modern system called ‘smart grid’ etc. Modern systems use sensors called Phasor Measurement Units (PMU) distributed throughout their network to monitor power quality and in some cases respond automatically to them.

Using such smart grid features of rapid sensing and automated self healing of anomalies in the network promises to bring higher quality power and less downtime while simultaneously supporting power from intermittent power sources and distributed generation, which would if unchecked degrade the power quality.

Different types of power quality parameters that should be monitored are given in Table 1.

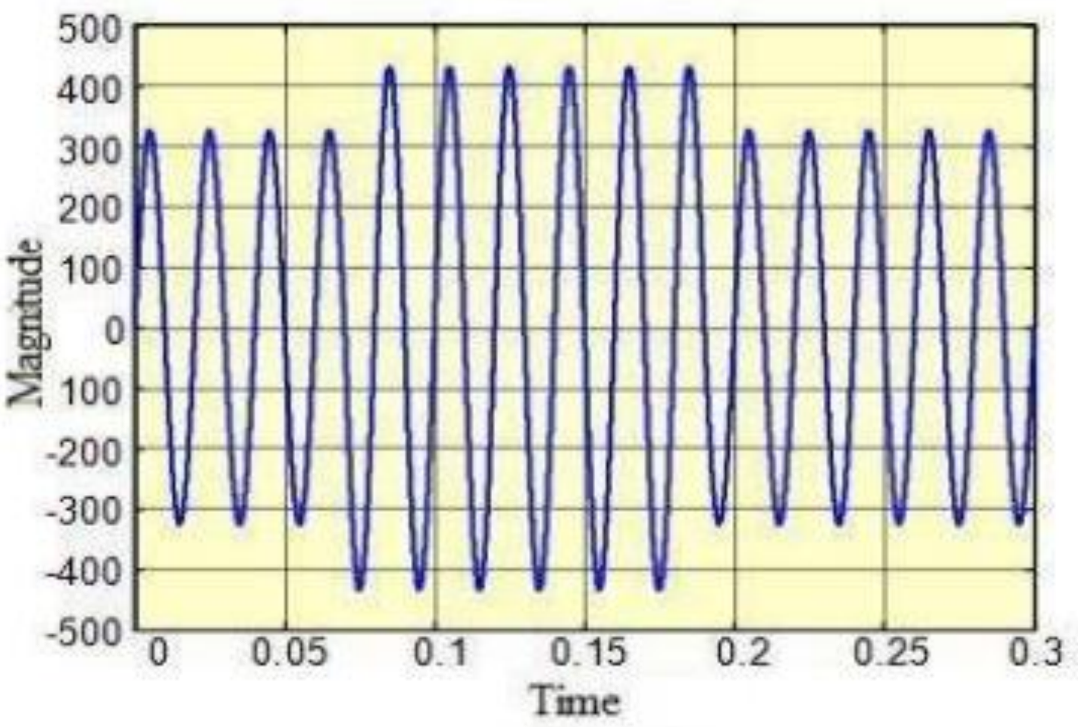
Methods for power quality problems correction

1.Proper designing of the load equipment.
2. Application of passive, active and hybrid harmonic filters.
3. Proper designing of the power supply system.
4. Application of voltage compensators.
5. Use of Uninterruptible Power Supplies (UPSs).
6. Reliability on standby power.

CHAPTER 3
DETECTION OF OVER VOLTAGES

3.1 Overvoltage

A Overvoltage is defined as an increase in the r.m.s. value of the voltage up to a level between 1.1 pu to 1.8 pu at power frequency for periods ranging from a half cycle to a minute as shown in fig Overvoltage.



Graph of overvoltage

Causes of Overvoltage

Over voltages are less common than under voltage but they also arise due to system faults. Overvoltage can occur due to single line to ground fault, which in turn will raise the voltage of the other phases. It can also cause due to disconnection of heavy industrial loads or switching on the capacitor banks[**from reference 6]**. This is generally due to ungrounded or floating ground delta systems, where a change in ground reference would give voltage rise to the ungrounded system.

Causes of overvoltage are mainly due to energization of capacitor bank. It can also be generated by sudden load deduction. Due to the disconnection of load, there is a sudden reduction of current, which will give rise the voltage, where L is the inductance of the line. The effects of overvoltage are more severe and destructive. It may cause the electrical equipment to fail, due to overheating caused by high voltage. Also electronic and other sensitive equipment are prone to malfunction.

Some more causes of Overvoltage are given below

1.Loss of a Secondary Neutral Open neutral

connections in 120/240-V customer installations can occur and have been reported under several circumstances, including:

- When corrosion of an underground service reaches an acute stage
- When the neutral wire of a separate-conductor service drop is broken by falling branches or Icing
- When an intermittent loose connection exists in the service panel

2.Ferro resonance

Ferro resonances is a special form of series resonance between the magnetizing reactance of a transformer and the system capacitance. A common form of ferro resonance occurs during single phasing of three-phase distribution transformers. This most commonly happens on cable-fed transformers because of the high capacitance of the cables. The transformer connection is also critical for ferro resonance.

An ungrounded primary connection leads to the highest magnitude of ferro resonance. During single phasing (usually when line crews energize or de-energize the transformer with single-phase cut outs at the cable riser pole), a ferro resonant circuit between the cable capacitance and the transformer’s magnetizing reactance drives voltages to as high as five per unit on the open legs of the transformer. The voltage waveform is normally distorted and often chaotic

Classification of overvoltage according to IEEE 1159

Types of Voltage	Duration	Magnitude
Instantaneous	0.5 – 30 cycles	1.1 – 1.8 pu.
Momentary	30 cycles – 3 sec	1.1 – 1.4 pu.
Temporary	3 sec – 1 min	1.1 – 1.2 pu.

3.Over voltages Due to Poor Voltage

Regulation Occasionally, over voltages occur because of the malfunction or misapplication of utility voltage regulation Equipment. Some scenarios that could cause over voltages include:

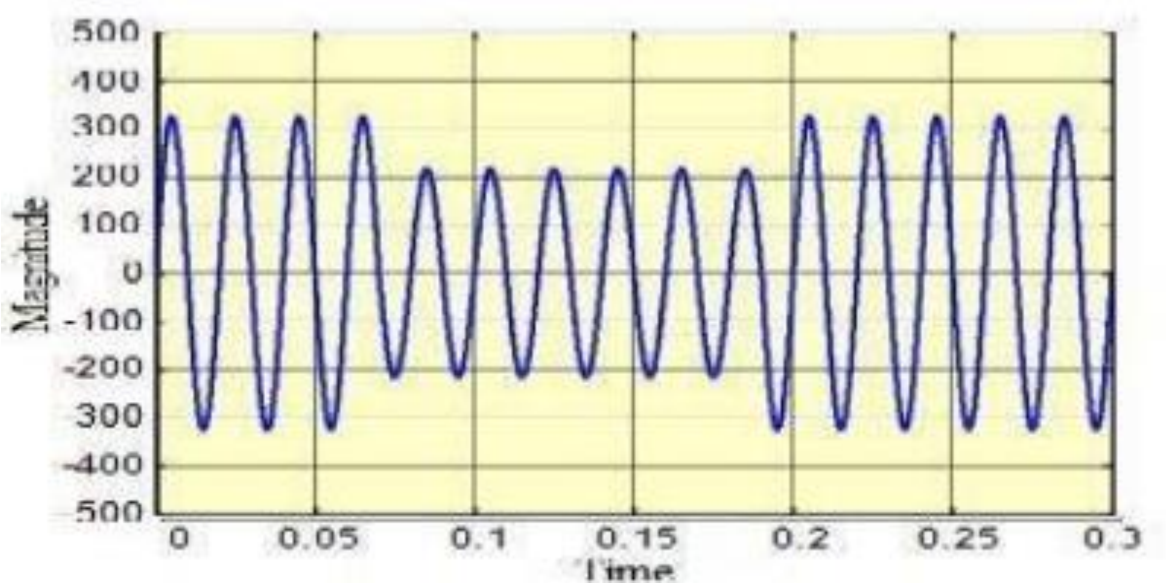
- Regulator installed or set incorrectly
- Malfunctioning voltage regulator
- Capacitor-bank controllers with an incorrect clock setting
- Malfunctioning capacitor-bank controller.

4.Accidental Contact to High-Voltage

Circuits Faults from transmission circuits to distribution circuits are another hazard that can subject distribution equipment and customer equipment to extremely high voltages. Consider the example of a fault from a sub-transmission circuit to a distribution circuit. As is the case for primary-to-secondary faults discussed in the previous circuit, overvoltage's are not extremely high as long as the distribution circuit stays connected (just like the primary to secondary faults discussed in the previous section). But if a distribution interrupter opens the circuit, the voltage on the faulted distribution conductor jumps to the full transmission-line voltage. With voltage at several times normal, something will fail quickly. Such a severe overvoltage is also likely to damage end-use equipment. The distribution interrupter, either a circuit breaker or recloser, may not be able to clear the fault (the recovery voltage is many times normal); it may fail trying.

3.2 Under voltage

Under voltage is defined as a sudden drop in the root mean square (r.m.s.) voltage and is usually characterized by the remaining (retained) voltage. Under voltage is thus, short duration reduction in r.m.s. voltage, caused mainly by short circuits, starting of large motors and equipment failures. Furthermore, under voltage may be classified by their duration as shown in



Under voltage graph

Under voltages are the most common power disturbance whose effect is quite severe especially in industrial and large commercial customers such as the damage of the sensitivity equipment’s and loss of daily productions and finances. The examples of the sensitive equipment’s are Programmable Logic Controller (PLC), Adjustable Speed Drive (ASD) and Chiller control. Under voltage at the equipment terminal can be due to a short circuit fault hundreds of kilometres away in the transmission system.

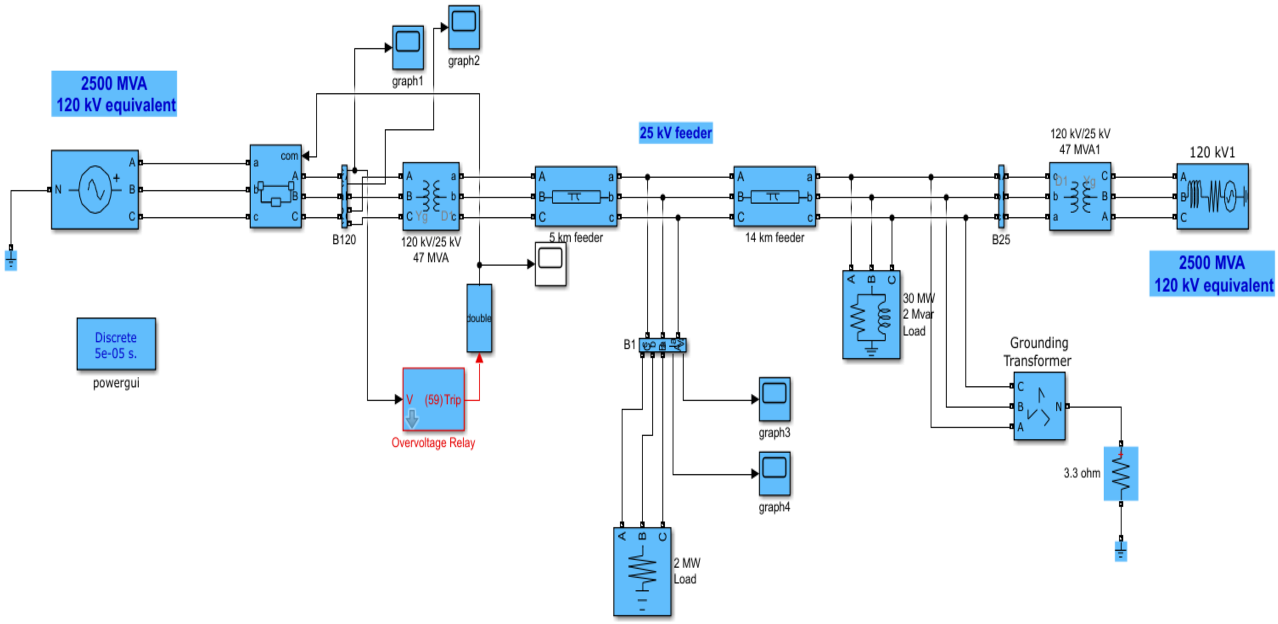
Causes of Under voltage

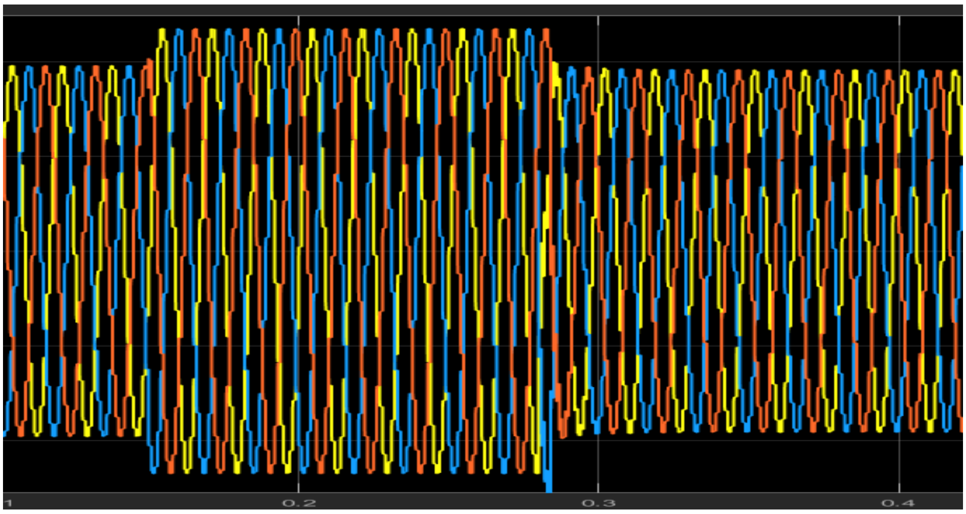
There are various causes for which under voltages are created in system voltage.

1. Closing and Opening of Circuit Breakers: When the circuit breaker of a phase is opened suddenly, then the line which it is feeding will be temporarily disconnected. The other feeder lines from the same substation system will act as an under voltage.
2. Due to Fault: Under voltage due to fault can be critical to the operation of a power plant. The magnitude of under voltage can be equal in each phase or unequal respectively and it depends on the nature of the fault whether it is symmetrical or unsymmetrical.
3. Due to Motor Starting: Under voltage due to motor starting are symmetrical since the induction motors are balanced three phase loads, this will draw approximately the same high starting current in all the phases.
4. Due to Transformer Energizing: There are mainly two causes of under voltage due to transformer energizing. One is normal system operations which include manual energizing of a transformer and another is the reclosing actions. These under voltages are unsymmetrical in nature.
5. Equipment Failure: Failure of electrical equipment occurs due to insulation breakdown or heating or short circuit etc.
6. Bad Weather: Lightning strikes in the power line cause a significant number of under voltages. A line to ground fault occurs when lightning strikes the line and continues to ground.
7. Pollution: Flash over takes place when there is storm in the coastal regions, where the power line is covered with salt. This salt formation acts as a good conductor of electricity and faults occur.
8. Construction Activity: Generally, all power lines are undergrounded in urban areas, digging for doing foundation work of buildings can cause damage to underground cables and create under voltages.

3.3 SIMULATION PROCESS

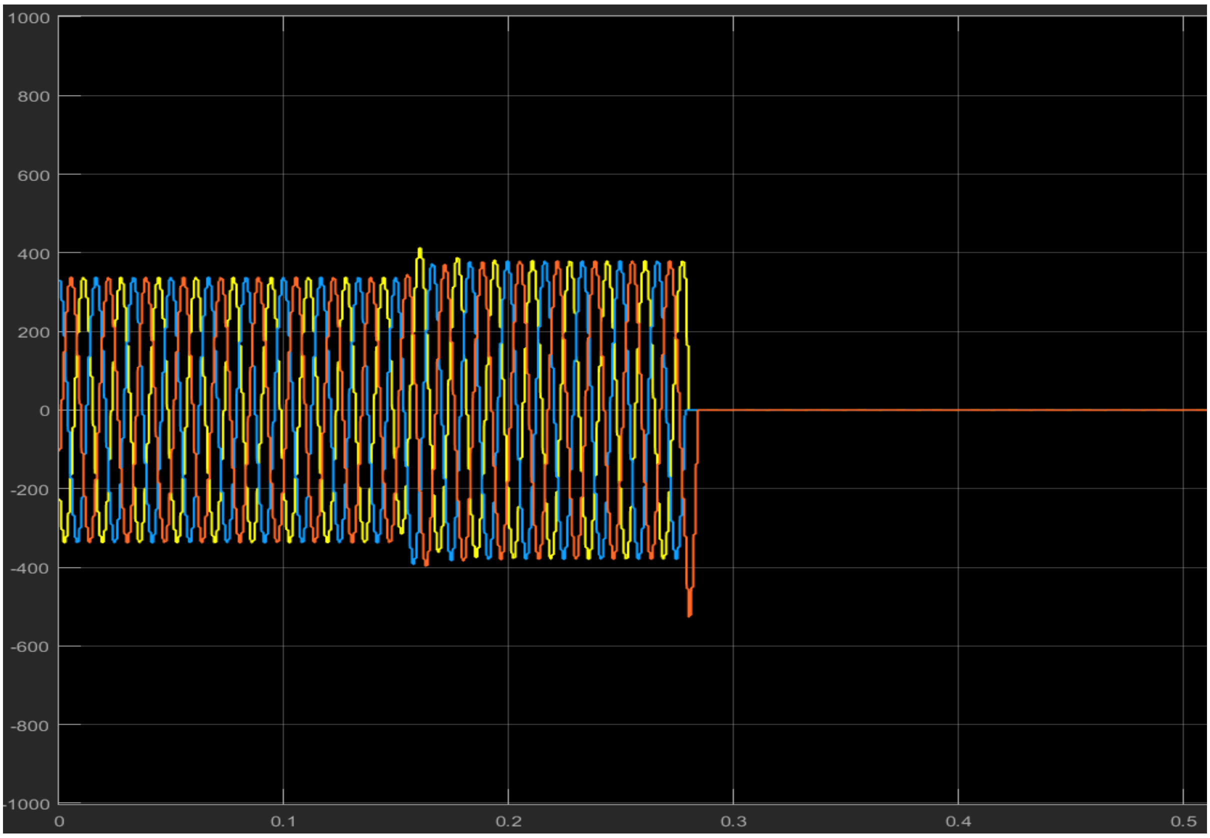
Over voltage detection:





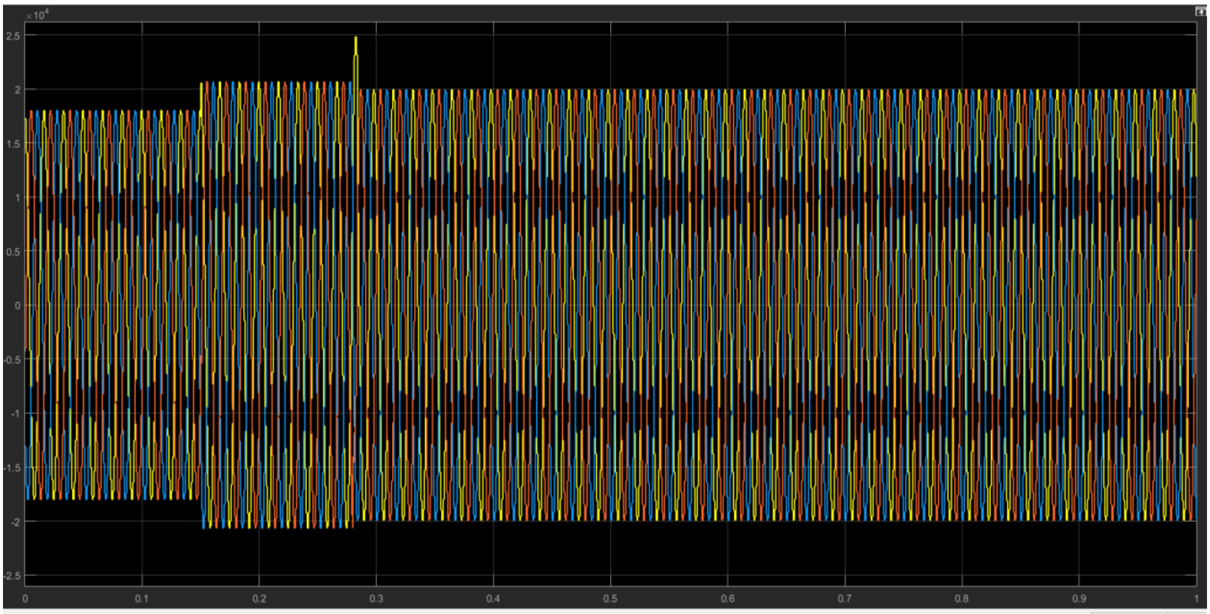
Graph1

- This graph showing over voltage in the grid network

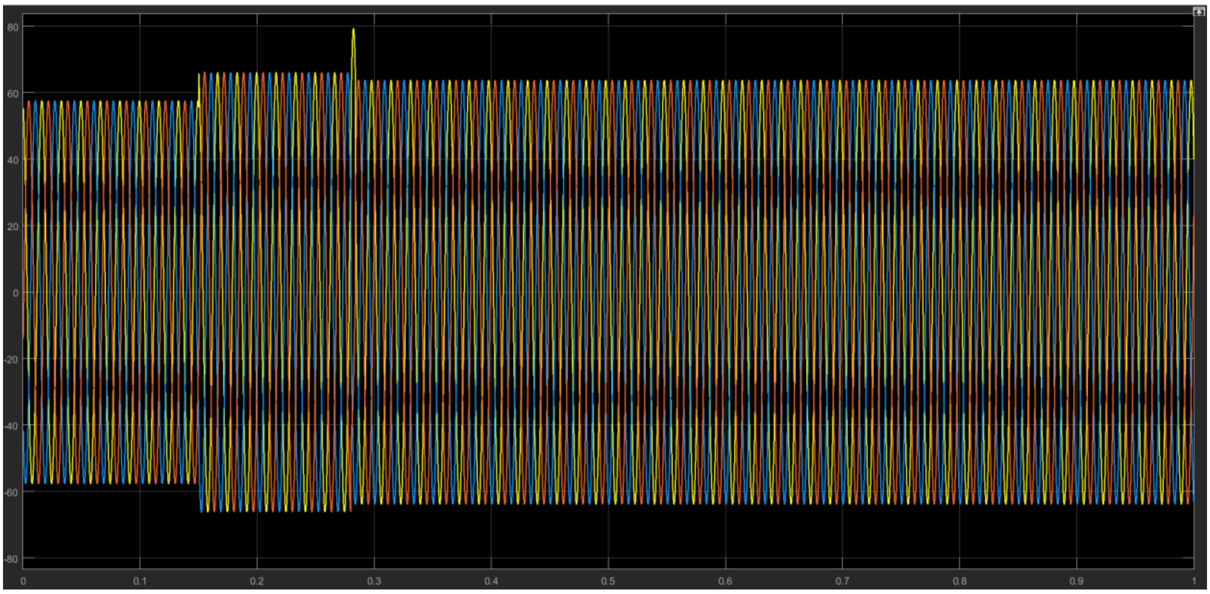


Graph2

- After operation of over voltage relay



Graph 3



Graph4

- When there are normal conditions in the network the over voltage relay will be in off condition. When there is over voltage then there will be some disturbance in the network. This we can observe in Three phase wave form. The comparator compares the voltage if the voltage exceeds beyond acceptable range the comparator gives signal to the over voltage relay. The over voltage relay isolates the circuit. After clearing the fault synchronisation grid network will come to normal position which is shown in the graph above.

CHAPTER 4

OVER AND UNDER FREQUENCY DETECTION

4.1 INTRODUCTION

Energy provides the power to progress. Availability of sufficient energy and its proper use in the country can result in its people rising from subsistence level to highest standard of living. Energy exists in different forms in nature but the most important form is the electrical energy. The modern society is so much dependent upon the use of electrical energy that it has become a part and parcel of our life. Several new trends have already employed in the electricity infrastructure. It includes the expansion of the existing grid with micro grids and mega grids, extensive sensors, data processing, visualization tools, etc. Increasing electrical energy demand, modern lifestyles and energy usage patterns have made the world fully dependant on power systems thus the need of a reliable and stable power system grid. However, the power system is a highly nonlinear system, which changes its operations continuously. Therefore, it is very challenging and uneconomical to make the system be stable for all disturbances. At present, the interest toward the distributed generation systems, such as photovoltaic arrays and wind turbines, increases year after year. But wind turbines and generally DGs will have affects in the power system network that one of these influences is an islanding phenomenon. Islanding refers to the condition in which a distributed generator (DG) continues to power a location even though electrical grid power from the electric utility is no longer present. Islanding situations can damage the grid itself or equipments connected to the grid and can even compromise the security of the maintenance personnel that service the grid. According to IEEE1547 standard, islanding state should be identified and disconnected in 2 seconds. This leads to idea of Automatic detection of Grid synchronization failure concept. Thus, the main consideration in our paper is to detect islanding in a grid.

4.2 ISLANDING

Islanding is a critical and unsafe condition in which a distributed generator, such as a solar system, continues to supply power to the grid while the electric utility is down. This condition is caused due to an excessive use of distributed generators in the electrical grid. Solar power generators, wind generators, gas turbines and micro generators such as fuel cells, micro turbines, etc. are all examples of distributed generators. The fact that anyone could supply electricity back to the grid causes the problem of islanding. It is a condition in which a distributed generator like solar panel or wind turbine continues to generate power and feed the grid, even though the electricity power from the electrical utility is no longer present. Also, it exposes utility workers to life critical dangers of shocks and burns, who may think that there is no power once the utility power is shut down, but the grid may still be powered due to the distributed generators.

To avoid this problem, it is recommended that all distributed generators shall be equipped which devices to prevent islanding. The act of preventing islanding from happening is also called anti-islanding.

Islanding causes many problems, some of which are listed below:

- Safety Concern: Safety is the main concern, as the grid may still be powered in the event of a power outage due to electricity supplied by distributed generators, as explained earlier. This may confuse the utility workers and expose them to hazards such as shocks.

- Damage to customer's appliances: Due to islanding and distributed generation, there may a bi-directional flow of electricity. This may cause severe damage to electrical equipment, appliances and devices. Some devices are more sensitive to voltage fluctuations than others and should always be equipped with surge protectors.

- Inverter damage: In the case of large solar systems, several inverters are installed with the distributed generators. Islanding could cause problems in proper functioning of the inverters.

WAYS TO DETECTS AND RESOLVE ISLANDING

There are many ways to detect islanding. These are categorized as under:

- Active islanding detection: Active detection methods involve the technique of constantly sending a signal back and forth between the distributed generator and the grid to ensure the status of electrical supply. In active methods, small disturbances are injected into the power system and its responses due to the injected disturbances are monitored. These methods change the balancing power between loads and generations, reduce the power quality of the power systems and are not suitable for wind farms with numerous wind turbines. Reactive power export error detection method, impedance measurement method, slip mode frequency shift algorithm (SMS), active frequency drift (AFD), active frequency drift with positive feedback (AFDPF), automatic phase-shift (APS) and adaptive logic phase shift (ALPS) are a few examples of active islanding detection methods.

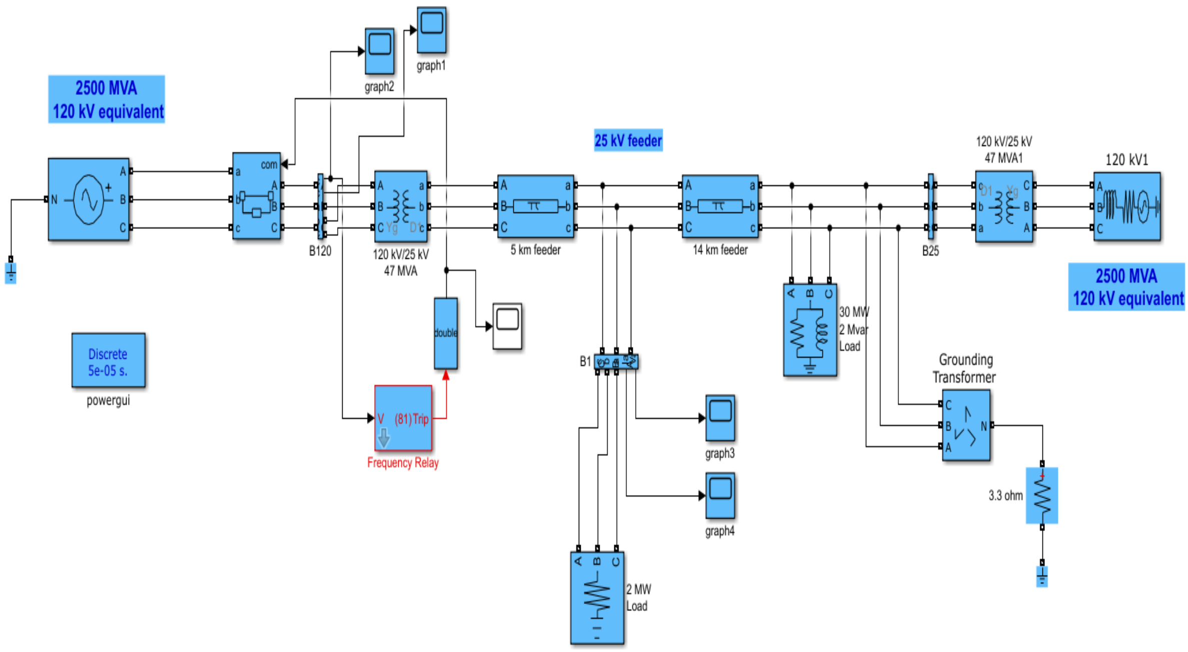
\• Passive islanding detection: Passive detection methods, on the other hand, make use of transients in the electricity (such as voltage, current, frequency, etc.) for detection. Passive methods continuously monitor the system parameters such as voltage, frequency, harmonic distortion, etc. Based on the system characteristics, one or more of these parameters may vary greatly when the system is islanded. The passive methods do not affect the waveform of the high voltage. This is beneficial since it does not give rise to power quality issues such as voltage dips. Setting a proper threshold can help to differentiate between an islanding and a grid connected condition. Rate of change of output power of DG, rate of change of frequency, voltage unbalance and harmonic distortion are a few examples of passive islanding detection methods.

• Methods not resident in the DG but communicating the DG and the utility: Methods not resident in the DG side but implemented on the EPS side are much complicated and expensive. The most important ones can be summarized as:

- Introduction of impedance –Small impedance, normally capacitive, is placed after the PCC on the EPS side. It only gets connected when the breaker DG-EPS is opened, unbalancing the local load.
- PLC Communication – Uses the ―Power Line Communications Carrier‖ technology to test if the DG is working isolated. SCADA Systems – With the help of a Supervisory Control and Data Acquisition System the EPS is checked and the potential islands detected. The quickest and easy way to prevent any problems is to shut off the distributed generator when requested by the utility.

4.3 MATLAB SIMULINK PROCESS

Over frequency detection:



Underfrequency Protection Characteristics

- Definite time delay
- Instantaneous reset time
- Hysteresis: fixed 1.0002
- Minimum breaking time: 50 ms
- Maximum breaking time (with time delay set to 0 s):
- 140 ms for frequency ramps from 0.5 Hz/s to 5 Hz/s according to IEC 60255-181
- 140 ms in case of sudden frequency change according to IEC 60255-181 for settings between 48 and 52 for 50 Hz application and 58 to 62 for 60 Hz application
- 200 ms in case of sudden frequency change according to IEC 60255-181 for settings between 45 and 55 for 50 Hz application and 55 to 65 for 60 Hz application

Setting Overfrequency Protection

- The settings for overfrequency protection are:
- Fmax mode: enables (ON) or disables (OFF) overfrequency protection on one phase
- Fmax action: sets the result of overfrequency protection activation as trip or alarm
- Trip: the circuit breaker trips and three events are generated (start, operate, and trip)
- Alarm: two events are generated (start and operate)
- Fmax inhibit: enables (ON) the protection to be inhibited by IO module
- Fmax: overfrequency protection threshold
- TFmax: overfrequency protection time delay
- They can be set as follows:
- With EcoStruxure Power Commission software (password-protected)
- With EcoStruxure Power Device app (password-protected)
- The dual settings function does not apply to overfrequency protection. When the dual settings function is enabled, overfrequency protection settings are the same whether set A or set B settings are activated.

3.4 RESULT:

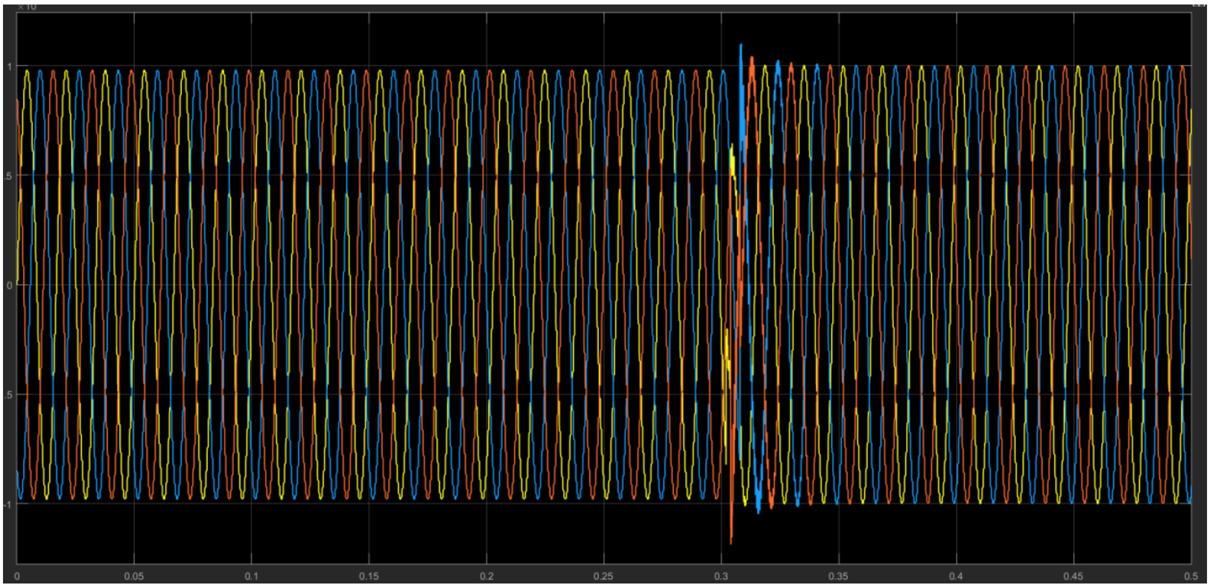


Figure 1

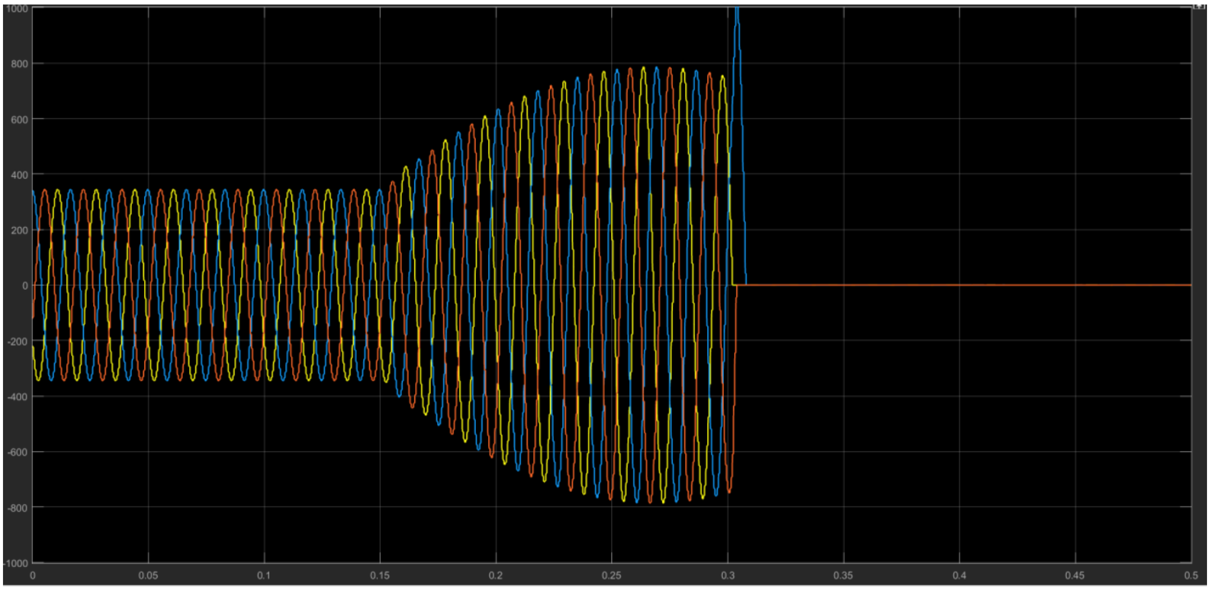


Figure 2

- Graph showing over frequency occurred in system

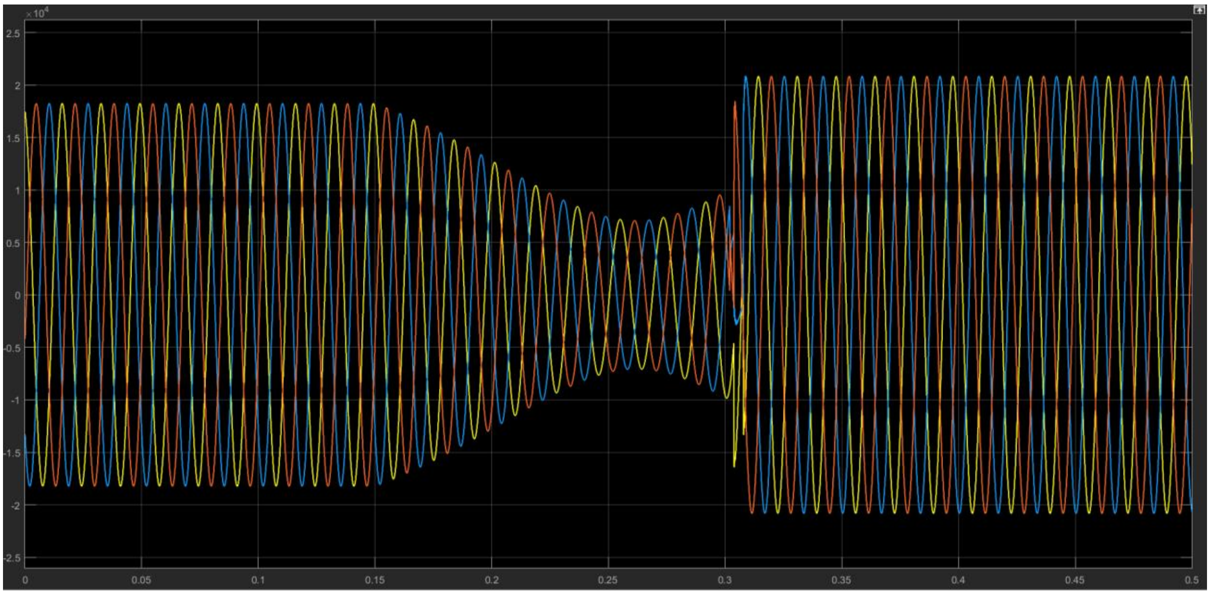


Figure 3

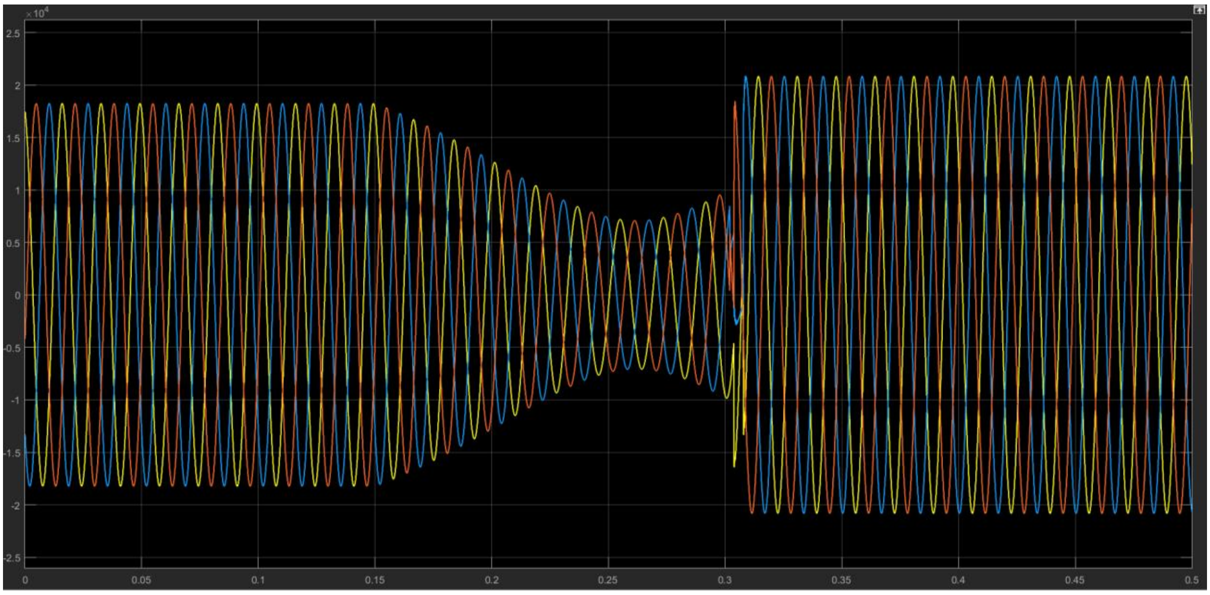


Figure 4

- Similarly, when there is a change in frequency that is below or beyond the 50hz frequency. The comparator compares the frequency with the nominal value if the frequency goes less than or greater than that nominal frequency. The frequency relay sends the signal and isolates the circuit. After the detection of over frequency, the network cuts off the circuit until it comes to normal frequency after clearing the fault.

CHAPTER 5

CONCLUSION

CONCLUSION:

The protection circuit can be used to protect the costly electrical appliances from abnormal conditions like sag, swell, under voltage and overvoltage and avoid appliances being affected from harmful effects.

The frequency in electrical installations must be maintained within accepted operating levels to minimize the risk of damage to motor loads, sensitive electronics, and to ensure the proper operation and performance of all loads.

There are two independent protections:

- underfrequency
- Over frequency

Under/over frequency protection constantly monitors the frequency. If the frequency of an installation exceeds its acceptable limits, the information delivered by the under/over frequency protection can be used to initiate appropriate action to restore good operating conditions in the installation. The under/over frequency protection is used to generate either an alarm or a trip, when required.

Under/over frequency protection is suitable for generator use. The continuous monitoring of frequency enables appropriate action to be initiated to safeguard the operation of the installation during abnormal or critical situations, for example, load shedding, source change-over, and emergency generator starting.

This implementation concludes that it is possible to have a power grid system that is smarter, more effective as well as efficient in its operation, thus proving to be more economical as compared to be the present installations.

CHAPTER 6

FUTURE SCOPE

FUTURE SCOPE:

If we control the tap changing transformer automatically then we can operate the load normally in under voltage and over voltage condition. Hence, we can protect as well as operate the load in abnormal voltage. This System can be later improved by integrating it with GSM modem that alerts user by sending an SMS about the tripping occurred

This paper gives brief idea about developing a system to detect the synchronization failure of any external supply source to the power grid on sensing the bad voltage and frequency. Number of distributed generators connected in parallel to the grid, to supply power to the load. Each generator having follow the rules of grid. These rules involve maintaining a voltage and frequency variation within limits. When any fault occurs on grid and due to this grid broken a rules and deviation occur in voltage and frequency. When deviation occur in grid feeder is mandatory to open from grid and this process is term as islanding. This prevents grid failure or blackout.

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