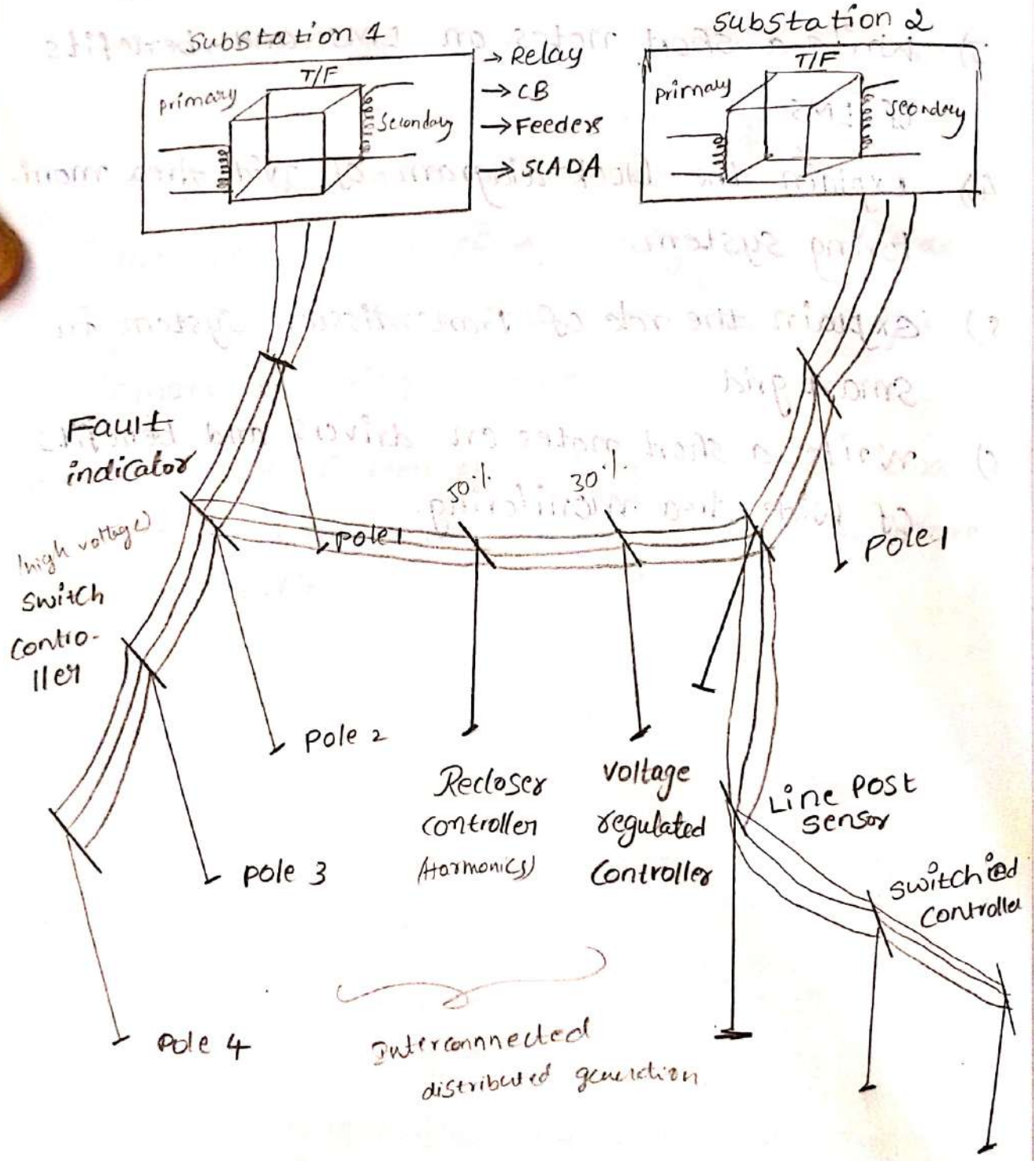
5. Smart Distribution system

DMS:

→ Distribution Management system.



Distribution SCADA:

→ Supervisory control and data aquisition (SCADA) systems are a relative mature technology for the management of distributed asset systems

→ While they have long been used for the management of generation and transmission systems they are increasingly being employed for the monitoring and control of distribution systems.

→ Technology advances that will aid in the deployment of SCADA technologies are still occuring particularly in the communications area. These are described in other aspects

→ The SCADA master hardware and software is typically located centrally at the control center

→ The control center consists of the SCADA application servers, the communication front end processors, a data history, interfaces to the other control system operator work stations and other supporting components.

→ The primary SCADA system is often redundant with a local backup system and/or remote backup at another site. Other system environment are often installed by the utility for testing and quality assurance development and training Various types of communications links to the remote terminal unit (RTUs) are used. These communications links are now becoming more

Ip based using open protocols

→ In the application of SCADA for distribution systems the costs of the additional sensors, IED (Intelligent Electronic devices), RTUs, Communications and SCADA master station must be considered relative to the benefits that are realized.

→ Monitoring and control of large distribution substations is usually always beneficial, but monitoring and controlling equipment further down the network on the distribution feeders is not widespread at least in the united states and other utilities with geographically large distribution systems.

VOLT/VAR Control

The VVC (Volt/var control) relates to switching of distribution substation and feeder voltage regulation and capacitor bank with two main objectives.

→ It reduces VAR flow on the distribution system.

→ Adjusting voltage at the customer delivery point with in required limits & optimize the control of both VAR flow and customer voltage.

1) VAR control
2) VAR compensation
3) power factor correction
4) conservation voltage Reduction (CVR)
5) Integrated volt/VAR control
6) volt/var optimization.

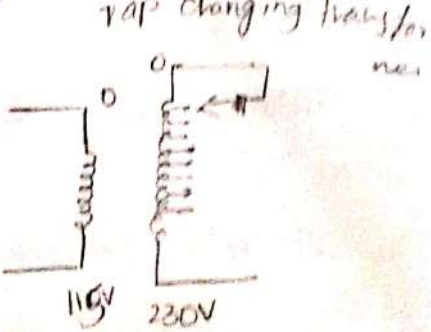
1) VAR control, VAR compensation, power factor correction.

i) substation and distribution feeder, capacitor bank are used to minimize VAR flow (improve the power factor)

2) Reduction of VAR flow, reduce distribution system loses and also reduce load on the substation.

Conservation voltage Reduction (CVR)

CVR is the control of substation of. LTC (Load Tap changing transformer)



→ Distribution feeder voltage regulator to reduce

customer delivery voltage within the specified. CVR may also be implemented during peak loads

Integrated VOLT/VAR Control (IVVC)

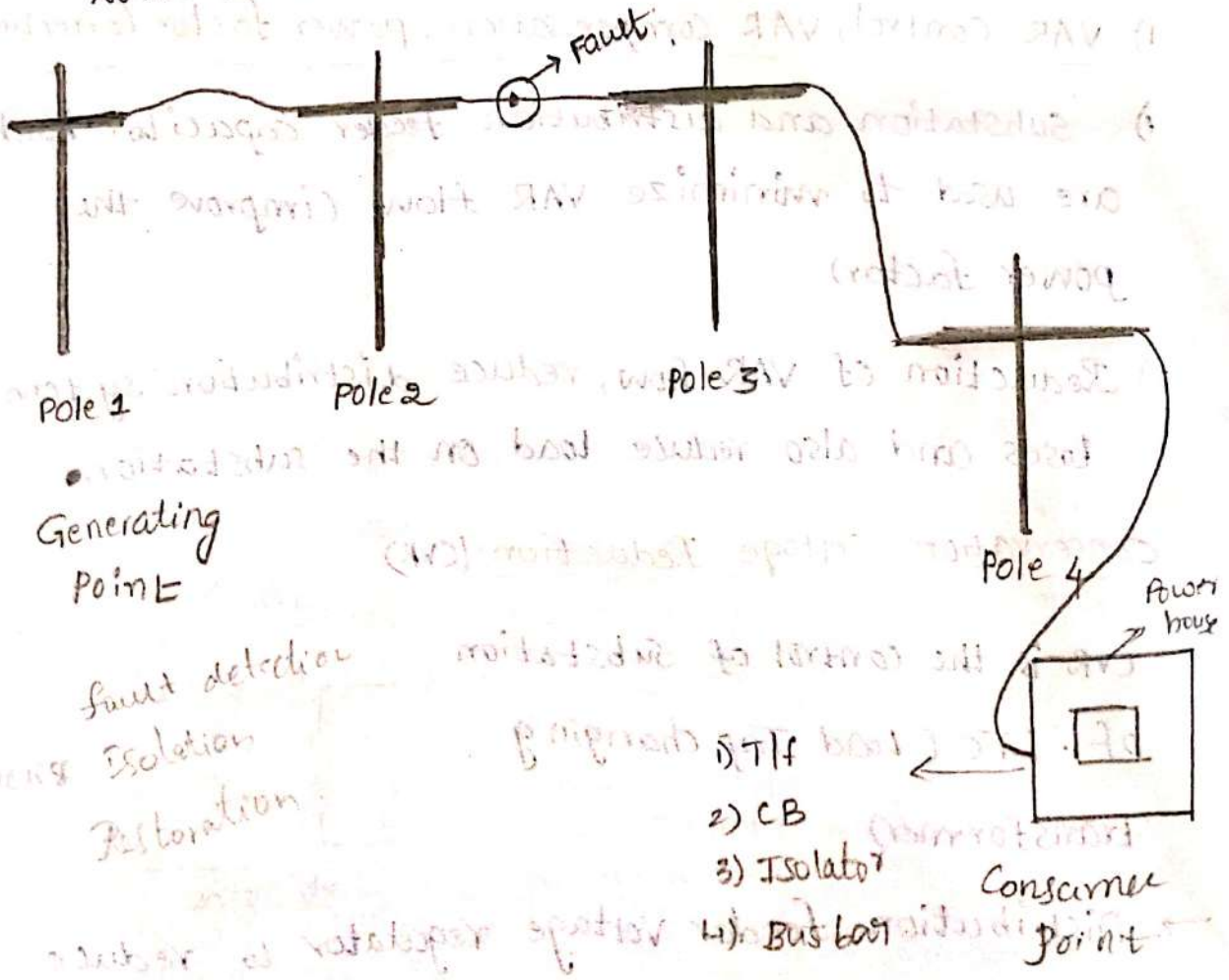
It is the Coordination of varflow & CVR to reduce distribution feeder losses and controls the voltage levels.

→ The main Concern of IVVC is to reduce the system losses and improve the service voltage.

Volt/var optimization

It is the capability to (min) optimize the objectives of VAR (loss), minimization and load Reduction using optimization techniques.

Fault Detection & Isolation Restoration (FDIR)



fault detection
Isolation
Restoration

1) Fault detection
2) precise isolation
3) Restoration

(1) Fault detection

→ FDIR has the ability to manage current fault during high activity & strom conditions
→ In situations vary assigned multiple fault incidence with in a single geographical area
→ FDIR is able to make common restoration, recommendations for multiple incident based on high voltages
→ The real time elecctrical network is constantly monitoring to detect or locate all potential fault Occuring.
→ Thefault detection mechanism makes uses of all available SCADA circuit breaker & fault detector (brea) status.

Some indicators (Red lamps) are used to send emergency message alerts to users for fault identification (high voltages, voltage swell, swag, fluctuations).

(2) precise isolation:

→ One failure is detected the next step is to locate the cause of that failure
→ Fault can be isolated manually by inspecting the burned out components
→ For more Complex system and time-critical mission, the fault can be also isolated.

Restoration:

→ Recommendations do not cause new over-loads a user-specified tolerance when implemented

→ The priority to restore entire de-energised islands if it is unable to do that

→ FDIR attempts to restore the maximum load possible by splitting outaged islands

→ Recommendations will minimize the switching actions.

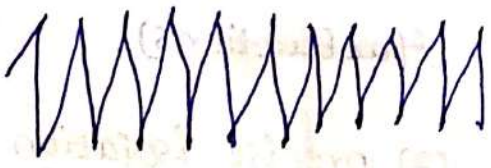
→ The priority is to transfer loads to immediately restoring (self-healing) [write about self healing also]

Voltage fluctuation:

→ Voltage fluctuations are systematic variations of the voltage envelope or random voltage magnitude of which does not normally exceed specified voltage range.

→ voltage fluctuations can be caused by:

(i) Lightning
(ii) strong winds
(iii) animals
(iv) trees,



voltage fluctuation

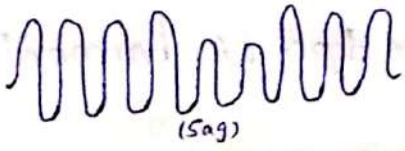
when they touch the power lines.

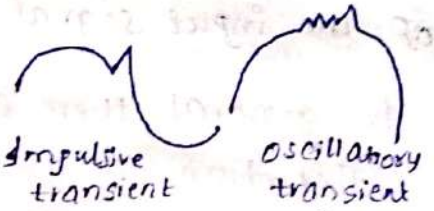
Power Quality issues

1) voltage interruption

(Short term Interruption)

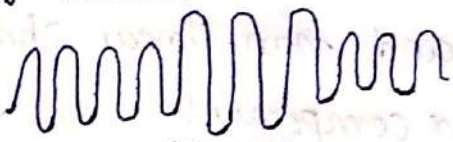
2) Voltage sag

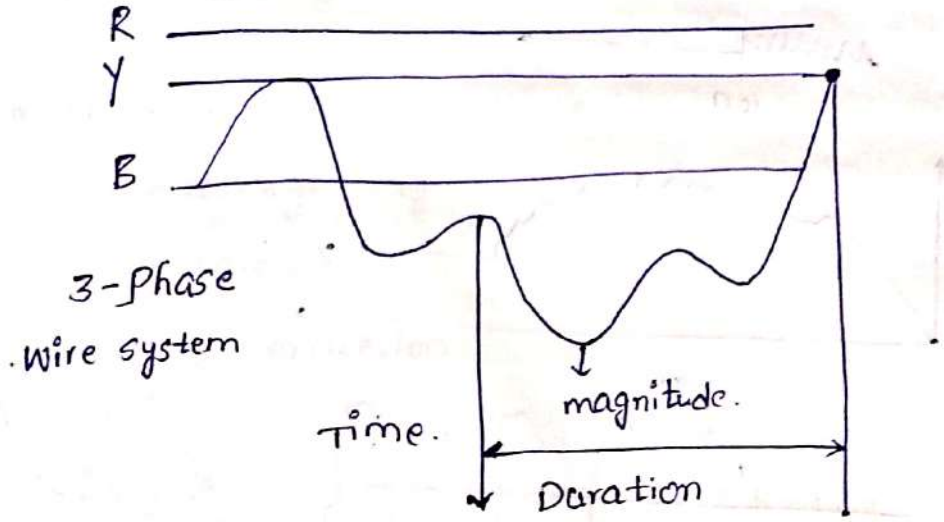




A voltage sag is a short duration that is (0.5 - 60 cycles) decrease in the rms voltage magnitude, usually caused by a fault (high voltage)

3) Voltage swell





→ A voltage swell is the opposite of dips and describe surge impedence in voltage of 10 %.

→ voltage swell (or) is normally due to large loads turning off suddenly.

→ This causes a sudden change in load impedence which can cause the voltage to swell

4) Harmonic distortion

Harmonic distortion is the presence of frequencies in the output of a device that are not present in the input signal and are multiples of components

of the input signal.

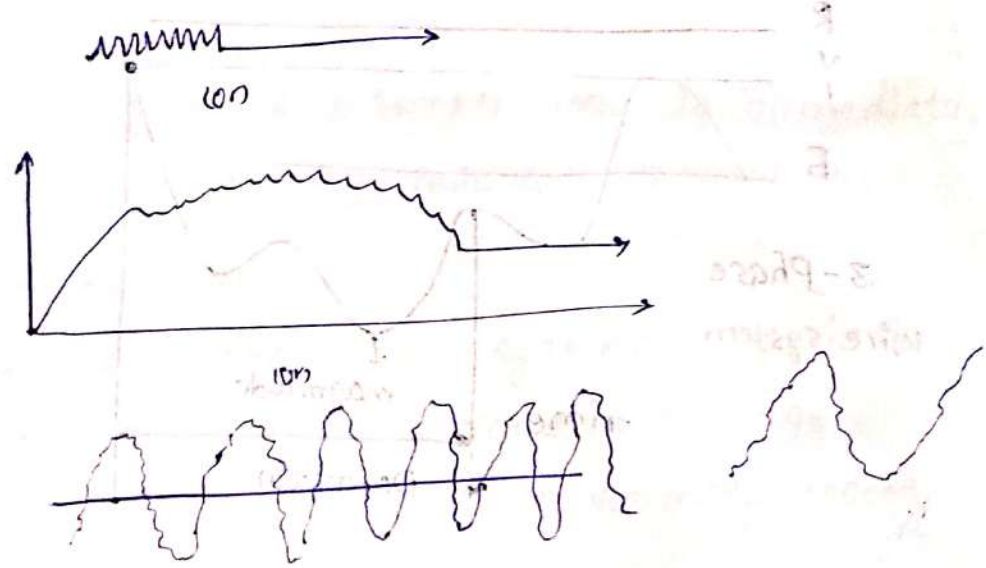
→ In general there are three types of harmonic distortion

(i) Amplitude distortion

(ii) Frequency distortion

(iii) Phase distortion.

→ The main reasons for Harmonic distortions are non-linear loads and non-linear characteristics of the electronic d component.



Harmonic distortion.

→ Distribution system voltage is too high that it can damage power delivery equipment such as transformer, consumer equipment.

→ High voltage can also reduce lighting products.

→ If the incoming voltage is too low, lighting will dim, motor will have less starting torque and overheat and some equipment such as Computer and TV will power down. In General rule

the low voltage will result in more damage to loads (lights, fans) on a distribution system as well as higher voltage cause more permanent voltage.

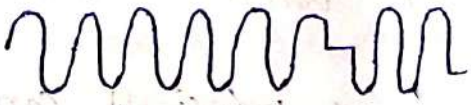
→ In distribution system the voltage at the customer without any means to compensate for the reduction of the distribution high voltage.

→ To regulate voltage levels at the substation and along the distribution feeder and voltage transformer

power Quality issues

a) Short duration variation:
   * voltage sag
   * voltage swell
   * Interruption

b) long duration variation:
   * under voltage
   * Over voltage
   * Sustained Interruption


long duration variation.

c) voltage unbalance

d) wave form distortion
   * Harmonics
   * Inter harmonics
   * Noise

2 Marks

1) What is voltage variations.

voltage variations is defined as systematic random variations in supply voltage. A rapid change in the supply voltage is called voltage variations or voltage flickering.

2) What is voltage control or voltage unbalance

voltage unbalance is defined as the largest difference b/w the average RMS voltage and the RMS value of single phase voltage divided by the average RMS voltage i.e., maximum deviation of voltage because single phase load in three phase circuit.

3) What is meant by transient?

A transient can be defined as the response of an electrical network to a sudden change in network condition

4) What is meant by Harmonics?

Harmonics are sinusodial voltage or current having frequencies as integer multiples of fundamental or supply frequency

The Harmonics due to increase in use of electrons.

5) What is voltage sag?

The increasingly sophisticated

equipment within residential customer or consumer installation in a particular, being made up of many components.

voltage sag and interruption are generally caused by (short circuit) fault on the utility system.

- A fault on the same feeder
- A fault on one of the other feeders from the substation
- A fault somewhere on the transmission system.

6) What is voltage fluctuations

voltage fluctuations / instability as well as voltage sag, dips, surge, voltage spike and power outage is the common problem encountered during integration of small scale energy from solar, wind into the grid.

7) What is VOLT/VAR optimization

volto/VAR optimization is a tool to dynamically adjust the distribution system to reduce system losses, and increasing the service voltage, minimizing the demand.

Industry experience with VOLT/VAR optimization showing the 1.5 to 3% demand reduction possible.

VOLT/VAR optimaization does not require engagement from consumer to achieve efficiency,

technology is implemented at system level.

Amount of benefits is related to load types, with maximum benefit for constant impedance load & lesser benefit for constant power loads (LED). All loads follow ohm's law ($V = IR$), but components can be designed differently.

types of loads

1) constant impedance load
2) Constant current load
3) constant power load.

1) Constance impedance load

resistance unchanged result in variable power from variable voltage.

2) Constant Current load

Resistance adjust to voltage results in variable power with different characteristic than constant impedence load.

3) Constant power load

Resistance adjust to voltage, results in variable voltage but constant power.

volt/var optimization uses load characteristics to achieve various objectives.

1) CVR mode:

Energy efficiency at system level.

2) Peak mode:

- Reduction of system capacity.
- Less capacity needs less power generation

3) Power quality Correction mode:

Correct system voltage losses in real time