A STUDY ON DISTRIBUTION OF ELECTRICITY

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Distribution of Electricity

ABSTRACT:

Safe electricity supply and economic facilities are two basic essential amenities, the community needs on a top priority for healthy living. While provision of safe supplying electricity takes precedence in the order of provision of basic amenities to community, the importance of economic facilities through low cost on required place.

Ever since the beginning of time amen has been faced with the problem of moving himself and the Distribution of Electricity needed for his existence. Hence movement is the common denominator in all the economic activities involving physical goods.

Electrical power is expressed in term of watts (w) and is given by $W = E \times I = I^2 R = \frac{E^2}{R}$, power is also expressed in terms of kw (kilo watt) (= 1000 w) or MW (mega watt) which is 1000 kw or 1000000 w.

Electrical energy is expressed in term of kilowatt hours (kwh). Thus 1 kwh = 1 kw x 1 hour = 1000 watt-hours = 1000 x 60 x 60 watt sec.

Through continuous thinking man has learnt to apply Distributions of Electricity principal through Transformer, Generator to washing machine, Radio, T.V. freeze, Bulbs, tube, machine & other electrical equipment etc. to provide safer and laser movement economically and safely electricity distribution systems occupy important position in every type of households, Agriculture, commercial shops offices, R & D & industries. According to electricity distribution means to supply of Electric power as well as to flow of power, it is the product of voltage, current & cos ɸ Voltage, current & cos ɸ must be moved from location to location, electricity distribution in Time i.e. it must assure that electricity

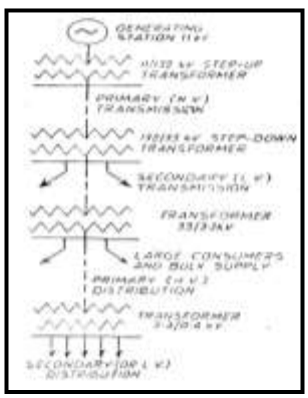
supply or customer need would require waiting Distribution of electricity is Quality- i.e. it has the responsibility of being sure that each location continually received the correct quality of supply voltage, current and power. Again distribution of electricity is in no space: no any storage space, flowing or passing of electric supply through the wire or conductor to the desired location. It is clear that distribution of electricity is the act of flowing of electricity in time and place utility, a distinct from Generating station which creates from Utility.

Transmission system and distribution networks form two main parts of a power system.

There is a large network of conductors' between the power station where electricity of is generated and the consumer who actually uses the energy. This network can be broadly divided into two parts- (i) Transmission (ii) Distribution.

Further sub-division under each class will be primary and secondary systems as we shall presently see.

A typical layout of such a system is shown in fig



It is not necessary that all schemes must have all the stages described above. For example in certain cases there may not be any secondary transmission or for that matter no primary distribution may exist in other types of network, some stages being suitably combined.

The distribution network comprises of feeders, distributors, mains, sub mains of service lines for consumers.

Some of the problems which we will have to consider in the following :

(a) Design of transmission system to transmit required power over a given distance
(b) System stability
(c) Design of distribution networks
(d) Substations

(e) EHV transmission

Transmission systems design will require a study of choice with reference to transmission voltage, constants of transmission line performance and design, interference with neighboring communication circuit besides lines insulation and corona proble

Transmission of electrical energy by various systems and their comparison on different bases.

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INTRODUCTION:

An efficent making of distribution of electricity plays on important role to increase the producer share in the consumer rupee. Presently the distribution of electricity marketing is mainly in the hand of bigman like industrialist, commission agents etc. the producer & distributers is only a price receiver. Therefore many times distribution of electricity suppliers have to restart to distress sale due to uncertain situation in marketing of distribution of electricity equipments, quality & price within backgroung the present study is taken up to analyse the existing marketing practices followed by distribution of electricity growers and to know the source of flow of market information

Electricity Supply System & Effect of System Voltage on Transmission Efficiency :

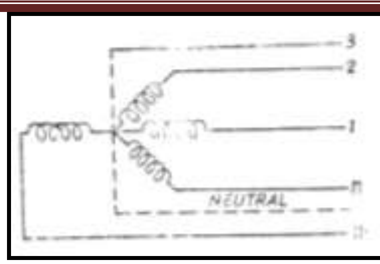
Consider an n phase system of transmission as shown in Fig. and let E be the voltage to neutral. If I be the current lagging E by an angle ϕ (phy) on each phase of the system power transmitted by each phase

$$P = \frac{EI \; Cos\,\phi}{1000} kW$$

If R is the resistance of each line conductor the power loss will be

$$P = \frac{I^2 R}{1000} kW/\,phase$$

If $_p$, I and A denote the resistivity of conductor, length of the line and the area of cross section of the conductor respectively then R = $\frac{pl}{A}$ so that we may write



If a fixed amount of power is to be transmitted the figure within the constant. It many be said therefore that the volume of conductor required is inversely proportional to the square of the voltage and that of the p.f. of the load.

Voltages used in India for different purposes are -

1. Generation; 6.6, 11, 33 kV
2. Transmission:100, 110, 132, 220, 400 kV
3. High voltage distribution to large consumes: 3.3, 6.6, 11 Kv
4. Low voltage distribution:

   AC : 400 V between phases, 231 V to neutral,

   DC: 3 wire 2 X 220 v

OBJECTIVE OF THE STUDY:

1. To study the efficient standard marketing practices of the distribution of electricity growers.
2. To know their source flow of distribution of electricity in required market information quality of supply for consumers and minimization of interruption of supply.

Distribution of Electricity program installation of network by using ie low tension line & 6.6KV. 11KV,22KV,33KV line in India with 50 Hz frequence and other country frenquency may be changed.

Comparison of Various Systems on the basis of Equal Maximum Potential Difference between conductors and Earth.

Assume equal power transmitted over equal length of the line with equal losses in the line and consider the following systems:

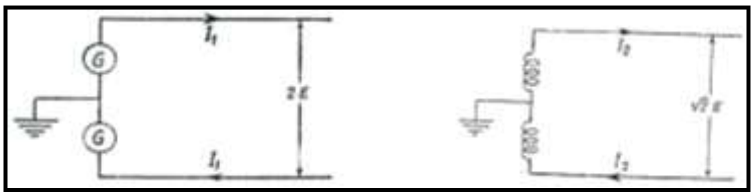
(i) D.C. 2- wire (ii) A.C. 1 –phase 2-wire

(iii) A.C. 2-phase 4- wire (iv) A.C. 2-phase 3- wire

(v) A.C. 3- phase 3-wire (vi) A.C. 3-phase 4-wire

i) D.C. 2-wire system

Let E be the maximum potential difference between any conductor and earth and I be the current. The mid point is earthed so that line voltage is 2 E (see Fig. A).



(a) (b)

Power transmitted = $2EI_1$ and power loss= $2I_1^2$ R 1 where R1 is the resistance of each conductor.

ii) Single-phase 2- wire System

If E is the maximum potential difference between any conductor and earth (fig. B).

$E_{rma} = \frac{E}{\sqrt{2}}$ and between conductors the value is $\frac{2E}{\sqrt{2}} = \sqrt{2}$ E

Distribution Systems for the same power to be transmitted at a p.f. cos ϕ

$$\sqrt{2EI_2}\, Cos\varphi = 2EI_1$$

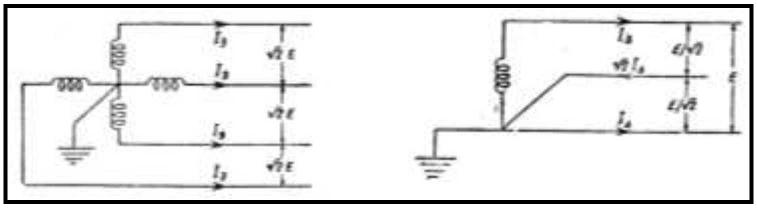
And, therefore, the line current $I2 = \frac{2EI1}{\sqrt{2}ECos\phi} = \frac{\sqrt{2}_1}{\cos\phi}$

If R_2 is the resistance of each conductor the power loss in transmission $\frac{2 \times 2I_1^2}{Cos^2\phi} \times R_2$ should be equal to $2I_1^2$ R_1, giving $\frac{R_2}{R_1} = \frac{Cos^2\phi}{2}$

In the present comparison both systems have the same number of conductors. Therefore, the cross-section a_2 and the volume of conductor required should be $\frac{2}{Cos^2\phi}$ times the respective quantities.

iii) Two-Phase 4 Wire System

A reference to Fig. c.



(c) **(d)**

shows that the systems can be considered as two independent single phase two- wire systems each carrying half the total power so that conductor size need be only half that calculated in (ii). 7 But number of conductors being double of (ii) the total volme of conductors remains the same, namely $\frac{2}{Cos^2\phi}$ times that in (i)

iv) Two phase 3 - wire System

The r.m.s. voltage between each outgoing conductor and the common return wire is $E/\sqrt{2}$ volts as shown in Fig. (d).

Let I4 be the current in each outer conductor, current in the common return wire thus being $\sqrt{2}\, I_4$. Let R be the resistance of each outer conductor. We will assume that all conductors can be worked at the same current density. As the current in the common return wire is $\sqrt{2}$ times the current in the outer conductor the cross section of the common return conductor should be $\sqrt{2}$ times the cross - section of the outer conductor. In other words the resistance of the common return conductor should be $\frac{R_4}{\sqrt{2}}$.

v) Three-Phase 3 Wire system

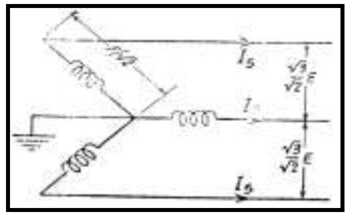
The system is shown in e.

The r.m.s. voltage to neutral $=\frac{E}{\sqrt{2}}$

Let I 5 be the current in each conductor; the power transmitted is 3 $\frac{E}{\sqrt{2}}$I s cosϕ which should be equal to 2 E I_1 giving

$$I_5 = \frac{2\sqrt{2}\, I_1}{3Cos\,\phi}$$

If Rs is the resistance of each conductor, the total power loss = $3I_5^2\, R$



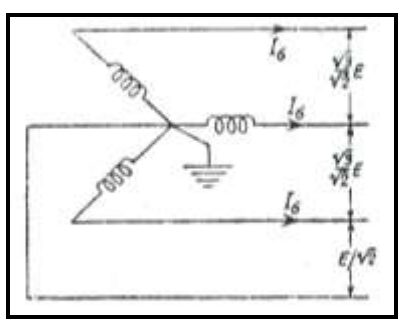
(e)

Which should be equal to the loss in d.c. system namely $2I_1^2\, R$

vi) Three phase 4 wire systems.

The only difference as compared with (v) is the additional neutral wire (fig. f) which if of the same size as the outers will mean 4 conductors instead of 3 so that ratio of volumes of conductor (compared with D.C. 2-wire system) is

$$4\left[\frac{\frac{4}{3\cos^2\phi}}{2}\right] = \frac{2.67}{\cos^2\phi}$$



(f)

All systems of transmission D.C., system is the ideal one ideal one resulting in the greatest economy. The difference between various a.c. systems and d.c. system becomes all the favorable for the latter when p.f. of the load which is usually less than unity is taken into consideration.

On the first basis among the a.c. systems there is no difference in I-phase or 3-phase 3 wire systems. The latter is however, to be preferred due to greater efficiency of polyphase plant and convenience.

On the second basis we find that a.c. 3-phase 3-wire system is the most economical of all the a.c. systems and also that this system is not so bad as compared with d.c. system when considerations like ease with which a.c. voltages can be stepped up or stepped down are taken into account.

For transmission where the first basis d.c. is decidedly the best system. For distribution where underground cables are usually employed a.c. 3 phase 3 wire system is most suitable.

ADVANTAGE AND DIFFICULTIES OF HIGH VOLTAGE D.C. FOR TRANSMISSION OVER LONG DISTANCES

The overhead system of transmission (or single core cables) the basis of comparison for conductor efficiencies is the maximum voltage to earth. This shows that D.C. system of transmission is cheaper in this respect than a.c. 2-phase 3-wire system.

Besides this advantage D.C. system of transmission has the following advantages :1. No skin effect. 2.Charging current (which contributes to continuous loss even on no load) is eliminated. 3. Line regulation is decreased because of absence of inductance and capacitance. 4. Corona limit is higher with D.C. than with a.c. 5. Problem of instability of transmission system (which arises from excessive reactive drop) is absent. Insulation difficulties are less.

A.C systems of transmission had the following advantages :

1) Easy transformation of voltage at generating/ receiving end.
2) Static sub stations which were necessary with a.c. were less costly and required less maintenance than rotary or rectifier sub-stations (with D.C.)

However now-a days energy can be easily and efficiently transformed from a.c. to D.C. and vice versa with electronic devices. In view of these developments the present day trend is towards a.c. for generation and distribution and D.C. for (high voltage) transmission.

Sub-Stations

Long and high voltage transmission lines are necessary to transmit huge blocks of power from the sources of generation to the load centers, to interconnect power houses for increased reliability of supply, greater system stability and lesser standby power plant and hence cheaper electric energy. In between the power house and ultimate consumer a number of transformation and switching stations have to be created. These are generally known as sub-stations.

Types of Sub-Stations

Depending on the purpose the sub-stations may be classified as:

1. Step-up sub stations
2. Primary grid sub-stations
3. Secondary sub-stations
4. Distributions sub –stations
5. Bulk supply and industrial sub-stations
6. Mining sub stations
7. Mobile sub stations
8. Cinematograph sub-stations.

The step up sub-stations are associated with the generating stations. The generation voltage is limited to a low value and needs to be stepped up to the primary transmission voltage so that huge blocks of power can carried over long distances to the load centers economically. The cinematograph sub stations are also specific purpose sub-stations and are required to meet special requirements.

Depending on the constructional features the sub-station may be further sub-divided into: (1) Outdoor type (2) Indoor type . (3)Basement or underground type (4) Pole mounting-open or kiosk type

For reasons of cost and safety it is common to have outdoor sub-stations for 33 kV and above.

Outdoor sub-stations may be of the low type or of the high type. The low type is more usual as it is more convenient to operate and service. In this type the equipment is arranged in one horizontal plane or levels.

Civil and Electrical Works in a Sub-station

A modern sub-station is a complex structure as it requires numerous items of equipment and allied services. The work on a sub-station starts from the civil and electrical survey of the area to choose the site. After the site has been selected and land acquired the work is divided primarily in to two groups viz civil works and electrical works. A. The civil works comprise of :

(1) Buildings
    (i) Residential
    (ii) Non-residential e.g. office, stores, repair, control room etc.
(2) Railway siding and railway track and overhead cranes
(3) Design and construction of foundation and transformer plinth

(4) Cable trenches.

(5) Fencing around switch yard

(6) Water supply

(7) Drainage and sewage

(8) Roads and paths

(9) Arboriculture.

B. The electrical works comprise of :

1. Choice of bus bar arrangement, preparation of key diagrams and layouts.
2. Selection of isolators instrument transformers, circuit-breakers, lighting arresters, power transformers, protective relaying schemes-control and relay boards, voltage regulating equipment and protection against lightning strokes.
3. Provision of facilities such as (i) earthing (ii) cabling (iii) oil handling system (iv) illumination system (v) compressed air system (vi) crane (vii) fire protection (viii) communication (ix) a.c. auxiliary supply (x) D.C. auxiliary supply and (xi) interlocks.

The design of sub-station should be cheap and economical, simple and flexible.

Bus-bars

TYPES the outdoor bus bars are either of the rigid or of the strain type. In the rigid type pipes are used for bus bars and also for making connections among the various equipments wherever required. The bus bars and the connections are supported on pedestal insulators. This leads to a low type of switchyard wherever required. The bus-bars and the connections are supported on pedestal insulators. This leads o a low type of switchyard wherein equipments as well as the bus bars are spread out thus requring a large space.

Material

In the case of rigid bus arrangement aluminum pipes are commonly used. The sized of pipes commonly used for various voltages are given below:

33kV	40 mm	220 kV	80 mm
66 kV	65mm	400 kV	100 mm
132kv	80 mm		

Since aluminum oxides rapidly great care is necessary in making connections. In case of long spans expansion joints should be proved to avoid strain on the supporting insulators due to thermal expansion or contraction of the pipe.

Materials in common use for bus bars and connections of the strain type are ACSR and all aluminum conductors. Bundle conductors are used where high ratings for bus bars are required. The following sized are commonly used:

33 kV	37/2.79 mm	ACSR
132 kV	37/4.27 mm	ACSR
220 kV	61/3.99 mm	ACSR
400 kV	61/4.27 mm	ACSR in duplex

Typical Power Scheme

The fig. A represents a typical power scheme by which the electrical energy is obtained from water power the water turbine acting as prime mover Let the alternators coupled to the water turbines generate 11 kV which is stepped up to 220 kV at the sending end and the power is transmitted over the two three phase circuits of the tramission line shown. At the receiving stations the voltage is reduced again to 33 kV with the help of a step down transformer. From these sub-stations again or sub station, where the voltage is further reduced to say 6.6 kV and a number of low voltage distributors will radiate out from these sub-stations to transforming stations reducing the voltage to 400/230 volts fig. A represent the line diagram of the power sachems.

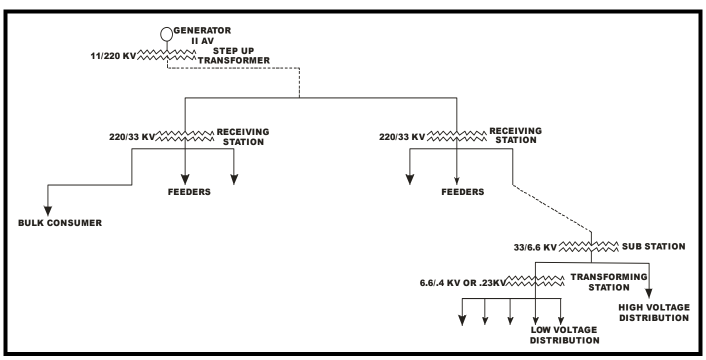


Fig. A : Power Transmission Scheme (line diagram)

1. Different Systems of Transmission and Circuits

Although only three-phases alternating currents is mostly used for transmission purposes, sometimes for special cases other systems are also useful. The different possible systems of power transmission are:

a. D.C. System

i. D.C. two-wire

ii. D.C. two wire with midpoint earthed.

iii. D.C. three-wire

b. Single –phase A.C.System

i. Single phase two-wire

ii. Single phase two wire with mid point earthed.

iii. Single phase three-wire.

Overhead Lines and its Mechanical Characteristics

An overhead line comprises mainly of (i) conductor, (ii) supports, (iii) insulators and pole fittings. The function of overhead lines is to transmit electrical energy, and the important characteristics which the line conductors must have are:

a. High electrical conductivity,
b. High tensile strength,
c. Low density, and
d. Low cost.

The metals which possess the above properties are copper, aluminum and steel which are used either alone or in combination.

1. Copper: The most common conductor used for transmission is hard drawn copper because it is twice as strong as soft drawn copper and it stretches' to a much lesser will be the conductivity. The conductivity of copper conductor also depends upon the method by which it has been drawn.

1. It has higher current Density, so for the given current rating lesser cross- sectional real of conductor is required and hence it provides lesser cross sectional area to wind loads.
2. The metal is quite homogeneous
3. It has low specific resistance
4. It is durable and had a higher scrap value.

Its properties are given in Table A.

2) Aluminum : Next to copper aluminum is the conductor used in order of preference as far as the conductivity is concerned .Its merits and demerits are:

1. It is cheaper than copper.
2. It is lighter in weight,
3. It is second in conductivity among the metals used for transmission commercial hard. Drawn aluminum wire at standard temperature has approximately 60-6 per cent conductivity in comparison to standard annealed copper wire.
4. For same ohmic resistance, its diameter is about 1.27 times that of copper.
5. At higher voltages it causes less corona loss
6. Since the diameter of the conductor is more so it is subject to greater wind pressure dug to which greater is the swing of the conductor and greater is the sag.
7. Since the conductors are liable to swing, so it requires larger cross arms.
8. As the melting point of the conductor is low, so the short circuit etc. will damage it.
   a) Joining of aluminum is much more difficult than that of any other material.

Because of shortage of copper ores in India, the use of aluminum in transmission and distribution lines has been adopted.

3. Steel: No doubt it has got the greatest tensile strength but it is least used for transmission of electricla energy as it has got high resistance. Bare steel conductors are not used since it deteriorates rapidly owing to rusting. Generally galvanized steel wires are used. It has the following properties:

1. It is lowest in conductivity.
2. It has high internal reactance.
3. It is much subjected to eddy current and hysteric's loss.
4. In a damp atmosphere it is rusted.

4. Aluminum Conductor with Steel Reinforced (A.C.S.R.) An aluminum conductor having a central core of galvanized steel wires is used for high voltage transmission purposes. This is done to increase the tensile strength of aluminum conductor. The galvanized steel core is covered by one or more stands of aluminum wires. The steel conductors used are galvanized in order to revent rusting and electro-chemical action between the two metals) The cross sections of the two metals are in the ration 1: 6, ut in case of high strength conductors their ratio is 1: 4 Thus the steel reinforced aluminum conductor has less sag and longer span than the copper conductor line since it has high tensile strength.

The aluminum steel conductor has a larger diameter than any other type of conductor of same resistance.

For all calculation purposes, it is assumed that the current is passing only in the aluminum section.

ELECTRICAL POWER

Single-Circuit Design	Double-Circuit Design
1. It is subjected to less wind pressure of conductors and structures so it requires less weight of steel tower member and lesser foundation. 2. Less danger at the time of repair 3. The design is not reliable as regards the continuity of supply. 4. Greater specie of the conductors is required. 5. Higher reactance as spacing between conductor is high	1. It is subjected to more wind pressure, structure is of heavier members the height of tower is more. 2. There is always danger from the other a live circuit. 3. The design is quite reliable as regards continuation of the suppl. 4. Lesser conductor spacing. 5. Low reactance as spacing is low.

The following are the methods of arrangement of conductors over the line supports:

i. Single phase circuits. The single phase transmission line can either be single circuit or double circuit. Fig A represents the most common method of single phase single phase circuit transmission fig A represents a double circuit single phase transmission line with conductors arranged in a horizontal disposition while Fig B represents double circuit with vertical disposition of conductors.

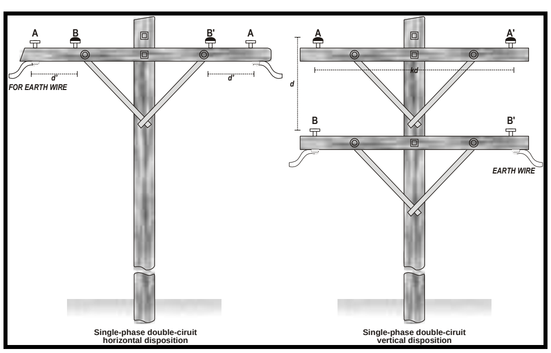


Fig. A **Fig. B**

POWER FACTOR IMPROVEMENT

1. Introduction

It has already been said that the power factor is the of kW component to the kVA component, consider fig C where

OA is kW component, or real power. OB is kVA component

AB is kVAR component, or the apparent power. Power factor,

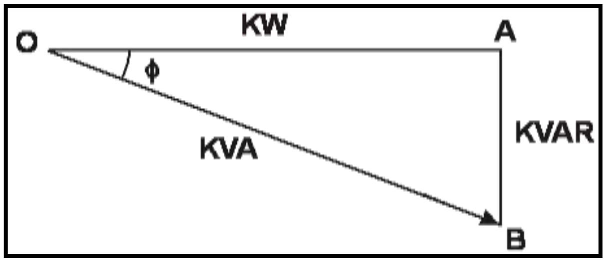


Fig C

$$\cos\varphi = \frac{\mathrm{Re}\,alPower}{kVA}$$

$$= \frac{kW}{kVA}$$

$$kVAR = kVA \times \sin\varphi$$
$$= kW\tan\varphi$$

The power factor will be leading if the current is leading the voltage and it is lagging when the current is lagging the voltage.

2. Causes of Low Power Factor

i) Most of the a.c. appliances have induction motor as their main drive which works at lagging power factor and they mostly contribute for the lagging power factor of the station.

ii) The transformers at sub-stations have lagging power factor because they draw magnetizing current which causes the total current to lag behind the voltage.

iii) The industrial heating furnaces have very low legging factor.

iv) Arc lamps which operate at low power factor.

v) The synchronous motor rotary converter and other commentator motors may work at leading power factor.

There are many serious defects of low power factor over the plants which are summarized as follows:

i. **Effect on transmission lines :** For the same power to transmit over the line it will have to carry more current at low power factors. As the line is to carry more current its cross sectional area will have to be increased which increases the capital cost of the lines. Also increased current increases the line loss or the efficiency of the line is lowered, and the line drop is also increased.

ii. **Effect on Transformers :** For decreased power factor, the kW capacity of the transformer is decreased and the voltage in it is increased.

iii. **Effect on Switchgear and Bus bars :** The cross-sectional area of the bus bar, and the contact surface of the switchgears must be enlarged for the same power to be delivered at low power factors.

iv. **Effect on Generators :** With the low power factor the kVA as well as kW capacities are lowered. The power supplied by the exciter is increased as well as the generator copper losses are increased, so their efficiency is decreased.

v. **Effect on prime Movers :** When the power factor is decreased the alternator develops more reactive kVA or the wattles power generated is more, but a certain energy is required to develop it which is supplied by the prime mover. That is, the part of the prime mover capacity is idle and represents dead investment working at low power factors also decreases the efficiency of prime mover.

3. Advantages of power Factor Improvement

Usually the suppliers induce the people to work at improved power factors by adopting a two part tariff charging the consumer on his maximum demand meter linked allied at consumer will try to will draw more current or his kVA demand is increased for which be will have to pay extra. This is how the consumer is discouraged to have low power factors.

The following are the advantage seen of the improved power factor:

1. The kW capacity of the prime movers is better utilized.
2. This increases the kilowatt capacity of the alternators.
3. The kW capacity of transformers and the lines are increased.
4. The efficiency of every plant is increased.
5. The overall cost per unit decreases.
6. The regulation of the lines is improved.

4. Methods of Improving Power Factor

Following are the methods of improving the power factor:

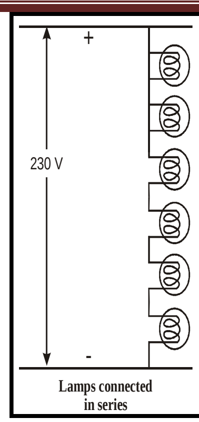
i. With the use of capacitors they are connected in parallel with the supply mains and take current leading by 90 from the mains which neutralizes the reactive lagging component of the load current.

ii. With the help of a a synchronous motor. This is the only motor which can also be worked at leading power factor at the same time this can supply mechanical power.

iii. Phase Advancers. These are special commentator machines which improve the power factor of induction motor.

1. D.C. Distribution

The electrical energy is generated at the generating stations by dynamos and is distributed at appropriate voltage which is kept constant. But according to Indian Electricity Rules voltage at the consumer's terminals must not vary beyond ± 5 per cent of the declared voltage. For example if at the consumer's premises must not be more than 242 V and less than all the lamps, fans heaters and other appliances in parallel with the supply mains. If the consumer connects all his six (say) lamp is replaced until and unless the fused lamp is replaced. Moreover the voltage (app) which is too less for the lamps. Also if one of the lamps develops short circuit be more than the desired value which causes excessive current to flow in the filaments of other lamps thus fusing one or even all of them.



FIG

Thus all lamps heaters, etc always connected in parallel.

Connected to a common copper bus bars, the word “bus is an abbreviation of the Latin word “Omnibus “Which means for all. The transmission lines which transmit the electrical energy form the generating station to different distributing sub-stations are called Feeders. The feeders may also be underground in which case they are called as cables. These feeders terminate into distribution and the consumers are connected by means of service Mains to distributors .Generally the sub-stations are inter-connected and mostly two system of D.C. distribution, i.e. 2 –wire and 3-wire are adopted.

The necessary requirements for a good distribution system are :

(i) Reliability i.e. there should be no power failures. If at all there is a power failure it should be for minimum possible time at all cost.

ii) The declared consumer voltage should remain within the prescribed limits i.e. within ± 5 % of the declared voltage.

iii) The efficiency of the lines should be maximum say about 90%.

iv) The transmission lines should not be over loaded.

v) The insulation resistance of the whole system should be high, so that there is no leakage and probable danger to human life.

vi) The system must be most economical.

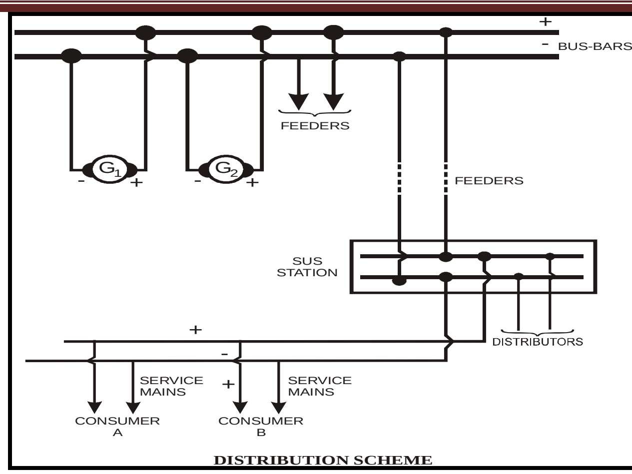


Fig.

Thus cables can well be used for transmission and Distribution purposes.

Classification of Cables

Although underground system is costlier and maintenance is difficult the system of transmitting power with cables is preferred in thickly populated areas and in cities. Cables are usually classified according to the voltage for which they are manufactured. According to the voltage they can be classified as :

(i) L.T. (Low Tension Cables) up to 1,000 volts.

(ii) H.T. (High Tension Cables) up to 11,000 volts

(iii) S.T. (Super Tension Cables) from 22,000 volts to 33,000 volts.

(iv) Extra High Tension Cables from 33,000 volts to 66,000 volts.

(vi) Oil filed under pressure and gas Pressure Cables for 66,000 volts to 1,32,000 volts.

Cable Conductor

The conductor of cables (sometimes overhead bare copper conductor also) is usually stranded. i. e. it consists of a number of strands of wire of circular cross-section so that it may become flexible and carry more current. In the stranded conductor each wire lies on a helix the pitch of which is so adjusted tha the cross section of the cable at right angles to its axis if practically circular. To avoid the bending and deformation of the cable conductor under normal conditions the alternate layers have right and left spirals. The successive layers are on concentric circles as represented in Fig. C. The numbers of strands in cables are 7, 19, 37, 61, 91, 127 or 169 as these numbers give the conductors a cylindrical formation. In case of a seven – strand or more strands cable the arrangement of these conductors is 7 strands – Six strands spiraled around a central strand as shown in Fig. 19.2 (a)

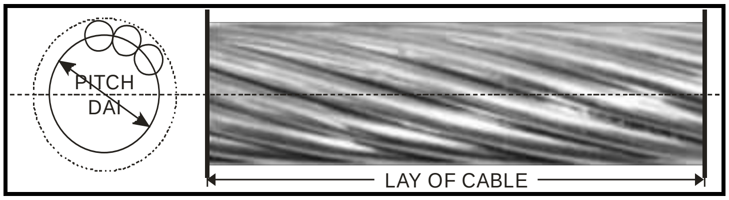
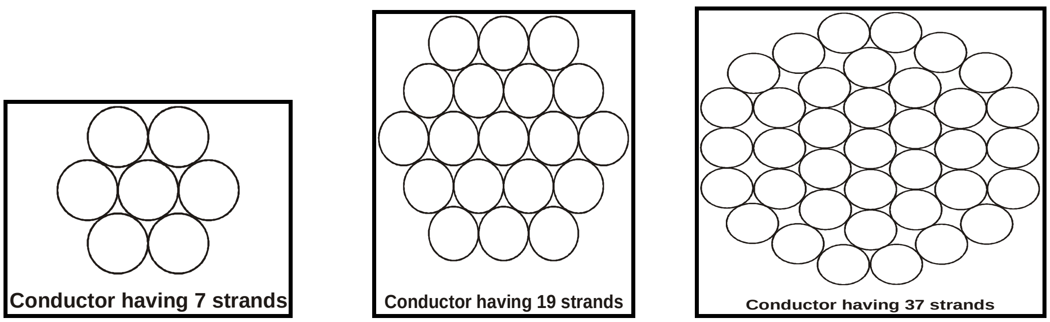


Fig. C

19 Strands – 7 strands as above with another layer of 12 strands; the direction of spiraling of this layer is in the opposite direction to the previous layer as shown in Fig.



37 Strands– 19 strands as above with an additional layer of 18 strands as shown in Fig.

In general the total number of conductors N in a n layer cable is given as

$N=1+3n(n+1)$

It should be remembered that the central conductor is not counted as layer

Thus if n=1, $N = 1+3(2) = 7$

For n=2, $N = 1+6(3) = 19$

The overall diameter D of a stranded cable with n layers is given as

$D = (1+2n)d$

Where d is the diameter of the single strand conductor.

In a 3-strand cable the above general formula is not used. Also in such a cable all the strands are spiraled about the axis of the cable and its overall diameter is given as

$$= \left(1+\frac{2}{\sqrt{3}}\right)d$$

The distance on the axis of the cable when the spiral takes one turn is called as the lay of cable as represented by Fig. C.

Domestic & Industrial Wire

- Range : Available in FR/FRLS/HR/ZHFR insulation
- Confirms to IS 694/1990
- Electrolytic grade over 100% pure copper
- Bunching of copper in uniform lay & diameter
- Double insulation with ultra thin Layer

Submersible Cable

- Stranded bare annealed electrolytic grade copper.
- Specially formulated FR PVC
- Range : 1.0 to 95.0 Sq. mm three core flat conductor
- Round submersible cable can be specially asked for
- Conforms to IS 694/1990

Requirements of the cables

The following are the necessary requirements of the cables.

i. The copper or aluminium conductor used should be of such size that the cable should carry the specified load without overheating and should cause a voltage drop within the limits.

ii. The cable must have the proper thickness of he insulation so as to give high degree of safety and reliability at the voltage for which it is designed.

iii. All the materials used in the cable manufacture should be such that there should be complete chemical and physical stability thoughout.

iv. The cable must be provided with a mechanical protection so as to withstand the rough use in laying it.

Cable Insulation

Cables are usually classified according to the type of insulation used. The type of insulation to be used must have the following properties:

i) It should have a high specific resistance
ii) It should have high dielectric strength
iii) It should be tough and flexible.
iv) It should not be hygro copic o,ie it should not absorb moisture from air or surroundings.
v) It should be capable of standing high temperatures without much deterioration.
vi) It should be non-inflammable.
vii) It should not be attacked be acids or alkalis.
viii) It should be capable of withstanding high rupturing voltages.

Although it is not possible to have all the above mentioned qualities in one particular type of insulation, the selection of a particular type of insulation to be used is dependent upon the purpose for which the cable is required and qualities of the insulation to be aimed at. The following are the chief types of insulation groups which can be used.

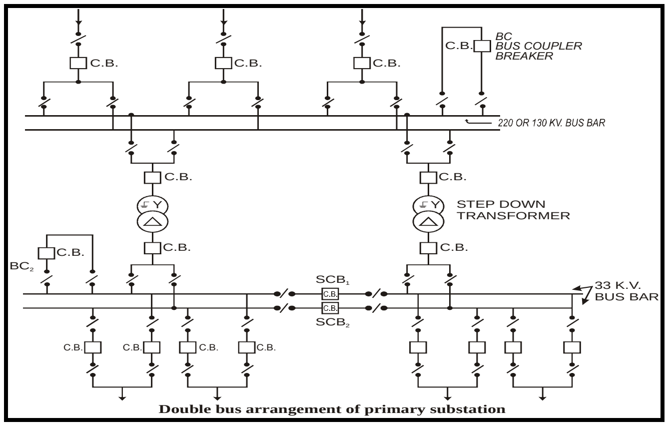
i) Rubber,
ii) Polyethylene.
iii) Polyvinyl chloride (P.V.C.)
iv) Fibrous material such as paper or jute etc
v) Vulcanized bitumen.
vi) Gutta – percha
vii) Silk, Cotton, enamael.

General Bus Arrangement (On high Voltage Side)

The Primary substations of a National Supply Grid confirm to a few basic arrangement. These arrangements are described in details so that one may get a good idea of basic pattern of substations generally met in practice. Each of the arrangements described has its own advantages. The choice of a particular arrangement depends upon the relative importance placed on such items as safety, reliability, simplicity of relaying, flexibility of operation, first cost, case of maintanence, availability of good area, location of connecting lines provision for expansion and appearance. The basic arrangements are of the following types :

1. Main and transfer bus

2. Double main bus with a single circuit breaker per circuit and circuit breaker by pass sandwitch.



Double bus arrangement of primary substation

Fig. D

3. **Double main bus with two circuit breakers per circuits**

4. **Breaker and a half wit two main buses.**

5. **Ring Bus**

In addition the substation design includes the decision about the following :

i) Whether rigid bus, or strain bus (using strain insulator) will be used;

ii) Whether aluminium bus or copper bus will be used.

iii) Whether shield wire should be used or not. The main disadvantage of it is that if it breaks, it will cause a servere short even more than that caused by lightning circuit, which may not be rectified in short time. Sometimes instead of this steel bayonets are used on the top of towers.

Transformer

A transformer is a static electrical device that transfers energy be inductive coupling between its winding circuits. A varying current in the primary winding created a varying magnetic flux in the transformer’s core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (emf) or voltage in the secondary winding.

Transformers range in size from thumbnail-sized in microphones to units weighing hundreds of tons interconnecting the power grid. A wide range of transformer designs are used in electronic and electric power applications. Transformers are essential for the transmission, distribution, and utilization of electrical energy.

Pole mountanted distribution transformer with center-tapped secondary winding used to provide 'split-phase' power for residential and light commercial service, which in North America is typically rated 120/240 volt.

The ideal transformer

Consider the ideal, lossless, perfectly coupled transformer shown in the circuit diagram at right having primary and secondary windings with N p and Ns turns, respectively.

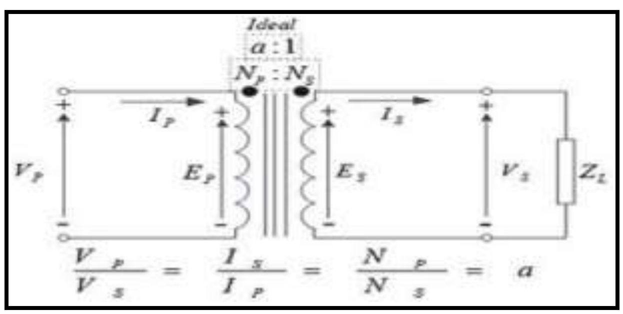


Fig. : Ideal transformer circuit diagram

The ideal transformer induces secondary voltage Es = Vs as a proportion of the primary voltage Vp=Ep and respective winding turns as given by the equation

$\frac{Vp}{Vs} = \frac{Ep}{Es} = \frac{Np}{Ns}$=a,

Where,

-Vp/Vs=Ep/Es=a is the voltage ratio and Np/Ns

= a is the winding turns ratio, the value of these ratios being respectively higher and lower than unity for step-down and step –up transformers,

- Vp designates sources impressed voltage,
- vs designates output voltage, and,
- Ep & Es designate respective emf induced voltages

Any load impedance Z L connected to the ideal transformer's secondary winding causes current to flow without losses from primary to secondary circuits, the resulting input and output apparent power therefore being equal as given by the equation

Ip x Vp=Is x Vs

Combining the two equations yields the following ideal transformer identity'

$$\frac{V\,p}{Vs} = \frac{Ep}{Es} = \frac{Np}{Ns} = a,$$

This formula is a reasonable approximation for the typical commercial transformer, with voltage ratio and winding turns ratio both being inversely proportional to the corresponding current ratio.

The load impedance Z L is defined in terms of secondary circuit and current as follows

$$Z_L = \frac{V\,L}{IL} = \frac{Vs}{Is}$$

The apparent impedance Z L of this secondary circuit load referred to the primary winding circuti is governed by a squared turns ratio multiplication factor relarionship derived as follows {6} {7}

$$Z_L = \frac{V\,p}{Ip} = \frac{a\,Vs}{Is/a} = a^2 \, X \, \frac{V\,s}{Is} = a^2 \, x \, Z_l$$

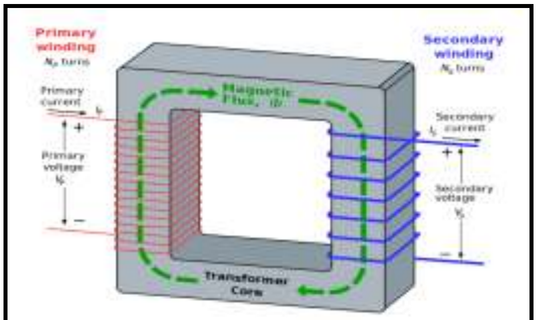
Induction law

The transformer is based on two principles: first, that an electric current can produce a magnetic field and second that a changing magnetic field within a coil of wire induces a voltage across the ends of the coil.

Electromagnetic induction changing the current in the primary coil changes the magnetic flux that is developed. The changing magnetic flux induces a voltage in the secondary coil.

Referring to the two figures here current here, current passing through the primary coil creates a magnetic field. The primary and secondary coils are wrapped around a core of very high magnetic permeability, usually iron so that most of the magnetic flux passes through both the primary and secondary coils. Any secondary winding connected load caused current and voltage induction from primary to secondary circuits in indicated directions.

The voltage induced across the secondary coil may be calculated from Faraday's low of induction , which states that:



Ideal transformer and induction law

$V_s = E_s = N_s \frac{d}{dt}$

Where Vs = ex is the instantaneous voltage, Ns is the number of turns in the secondary coil and d / dt is the derivate {d} of the magnetic flux through one turn of the coil. If the turns of the coil are oriented perpendicularly to the magnetic field lines, the flux is the product of the magnetic flux density B and the area A through which it cuts .The area is constant, being equal to the cross-sections area of the transformer core, whereas the magnetic field varies with time according to the excitation of the primary. Since the same magnetic flux passes through both the primary and secondary coils in a ideal transformer the instantaneous

Voltage across the primary winding equals

$V_p = E_p = Np \frac{d}{dt}$

Taking the ration of the above two equation gives the same voltage ratio and turns ratio relationship shown above, that is,

$\frac{V p}{Vs} = \frac{Ep}{Es} = \frac{Np}{Ns} = a,$

The changing magnetic field induces an emf act aross each winding. {8} The primary emf. Acting as it does in opposition to the primary voltage, is sometimes termed the counter emf. {9} this is in accordance with Lens's \law, which states that induction of emf always opposes development of any such change in magnetic field.

As still lossless and perfectly-coupled, the transformer still behaves as described above in the ideal transformer,

The real transformer

Real transformer deviations from ideal.

The ideal model neglects the following basic linear aspects in real transformers.

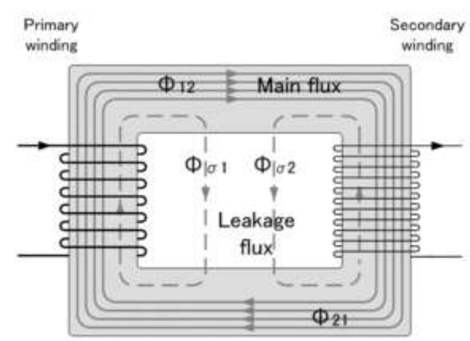
Core losses collectively called magnetizing current losses consisting of :

instrument transformer,
with polarity dot and X1 markings
on LV side terminal

- Hysteresis loses due to nonlinear application of the voltage applied in the transformer core
- Eddy current losses due t joule heating in core proportional to the square of the transformer's applied voltage.

Whereas the ideal windings have no impedance, the windings in a real transformer have finite non-zero impedances in the form of:

- Joule losses due to resistance in the primary , and secondary windings
- Leakage flux that escapes from the core and passes through one winding only resulting in primary and secondary reactive impedance.



Leakage flux of transformer

The ideal transformer model assumes that all flux generated by the primary winding links all the turns of every winding, including itself. In practice, some flux traverses paths that take it outside the windings. The combined effect of the leakage flux and the electric field around the windings is what transfers energy from the primary to the secondary.

Air gaps are also used to keep a transformer from saturating, especially audio-frequency transformers in circuits that have a DC component flowing through the windings.

Referring to the diagram, a practical transformer's physical behavior may be represented by an equivalent circuit model, which can incorporate an ideal transformer.

Winding joule losses and leakage reactance's reactance are represented by the following series loop impedances of the model: Primary winding: Rp Xp. Secondary winding Rs, Xs.

Distribution Transformers

We offer a wide range of transformers that are utilized electrical power supply. Electronic products and various other applications made using premium raw materials that have been tested for quality our range of transformers are of world class standards. They are available in different voltage and power supply we offer custom designed features to suit out customer needs.

Transformer Rating: 25 Kva to 2000 kva

Distribution transformers are utilized for transferring electrical power from one circuit to another and increasing or decreasing the voltage to the required amount. We use a premium grade of raw materials and wires for manufacturing these products. Our quality control team apply stringent measurements to ensure the safely and performance of the transformers.

- Suitable for multiple applications
- Available in various voltage and frequency
- Custom-designed to meet customer requirement
- Compliant with imitational safety standards
- Easy maintenance and installation

Control panel

Our range of control panels are widely utilized for industrial purposes. They consist of low temperature rise and prefer good voltage regulations Made under stringent quality control measures our manufacturing process adheres to industry norms and practices. They are tested for performance and efficiency and are know to run with minimal noise Few key features include.

- Easy mounting features
- Simply maintenance
- Tested for performance and smooth functioning
- Minimal operational noise
- Custom-designed to meet customer requirement.

Transformer Bushings

We offer kv transformer bushings extra high creep age bushings for areas with very pollution with modern features as per industrial standards and requirements out 1.1 kv bushings are available in different models and specifications we offer busing at competitive price range out range of transformer bushings is available in voltage

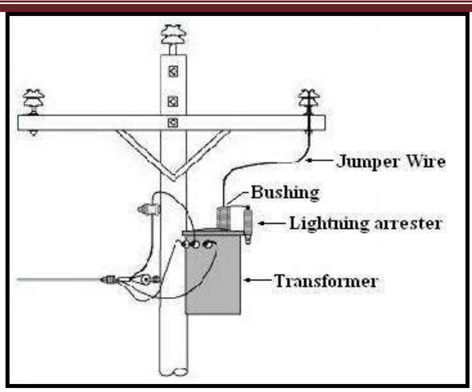
High Voltage Surge Arresters

The High voltage surge arresters are designed to guard the electrical devices from high voltage spikes that can damage the device beyond repair. These arresters are easy to install and are highly efficient and durable the arresters ensure safe and economic supply of electricity.

Safe secure and economic supply electricity our product portfolio both still come and porcelen hoursed arresters up to 800 kv and class 5.

Lightning Arresters

We offer lightening surge arresters are used to prevent the buildings from natural lightening during the rain. These have been very effective and have been appreciated all actors the globe further these help in preventing the buildings & industries from lightening damages.



HT/LT line upto 33 KV

It is our domain expertise that enables us to undertake the production, installation testing and commission of HT/LT lines up to 33 kv. We have been successfully providing our clients with poles, conductor/cables insulators hardware fittings and cab at an incredibly reasonable price unlike our competitors we approach only the reliable vendors so as to source exceptionally qualitative material. Timeliness is another aspect that we pay need to hereby giving no reason to our clients to be dissatisfied.

Salient features

- In tandem with industru standards
- High durability
- Unmatched performance

11/33 KV Substation Erection

We are recognized as one of the leading names in offering erection services for the installation of both indoor as well as outdoor sub stations. Following are some of our achievements in this field:

- We also offer unmatched tower erection services.
- We efficiency erect transmission lines up to 33 KV on turnkey basis.
- We are successfully engaged in electrical substation installation.
- We also efficiency maintain existing 11KV & 33KV.

Indoor sub-station

We are also install the indoor substaions of different ratings. They are built outside cities usually at points along the cross country lines of builk transmission systems.

VCB Panels

Our VCB panel available with a series of accessories provides convenience to the user by offereing high interruptting perfomanance. The panels have long lasting electrical and machanical life and hence eliminate the frequent expenditures met in replacing the fuses.It also has a raliable operating mechanism that ensures the safety of the recurits.

Transparent Pilfer Proof Meter Box

- Made from engineering plastic
- Meter push buttons can be accessed without opening meter box cover.
- Meter optical port can be accessed without opening meter box cover
- Push buttons & Optical provided on meter box cover are sealable

Three Phase Electronic Energy Meter with LCD Display (Available with & without optical comm., port)

- Accuracy class 1.0 as per ISI 3779/CBIP 88/IEC
- ISI marked ratings : -/54 CT operated, 5-20A, 10-40A, 10-60A
- All standard anti tamper features provided Optical communication port (Optional)
- Longging & display of tamper data
- TOD, load survey data, tamper information downloadable to CMRI through optical port.
- Optional features : Display in absence of power supply

Single Phase Electronic Energy Meter with LCD Display (Available with & without optical comm., port)

- Accuracy class 1.0 as per ISI 3779/CBIP 88/EC
- ISI marked ratings:-/5A CT operated, 2.5-10A, 5-20A, 5-30A, 10-10A, 10-60A
- All standard anti tamper features provided

- Optical communication port (optional)
- Logging & display of tamper data
- Optional features:
- TOD, load survey data, tamper information downloadable to CMRI through optical port.
- Display in absence of power supply

Trivector Meter (ISI Marked)

- Range : LT-CT operated -/5A
- CT/PT operated -/5A & -/1A for HT application
- Accuracy class 0.5 as per IS 14697/CBIP 88/IEC
- Logging& display for tamper data
- Measurement & recording of harmonic energy
- Communication: Optical & hardwired
- TOD, load survey data, tamper information downloadable to CMRI through optical port.

êbrit: Single & Three Phase Ammeter

- Push button based site programming of CT ratio
- Bright 4 digit 14mm LED display
- Colour indication for R, Y & B phases
- Universal Auxillary Supply-80 to 300 AC/DC
- Same model for A& KA
- Push button for phase selection (For Three Phase meter)

Three Phase Panel Mounted Meter with LCD Display (CT2E) CT Operated –/5A in class 1.0 accuracy

- CT Primary programmable upto 6000A (For Direct reading)
- No separate Auxillary supply required.
- Low Power Consumption less then 1 watt per phase
- Pulse Output

CONCLUSION:

It can be concluded that some manufacturer & distributors of distribution of electricity are grading their efficient distributors before taking to the market & consumers. Hence this calls for proper utilization by the consumer to create awareness about importance of grading and use them. They should involve the consumer in each and every manufacturer & distributor of distribution of electricity activity in local vicinity increase the number of programmer in the area. The official should develop and maintain good rapport with all the distribution of electricity consumers .

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