LIST OF EXPERIMENTS

1. Study of Ferranti Effect.
2. Determination of ABCD Parameter (T & π model) using MATLAB.
3. Determination of ABCD Parameter with effect of length of line.
4. Shunt capacitance compensation in transmission line using MATLAB.
5. Shunt capacitance compensation in transmission line.
6. Distribution system power factor improvement using switched capacitor.
7. Transformer oil test.
8. Determination of string efficiency using MATLAB.
9. Determination of string efficiency.
10. Study of corona discharge/ Earth resistance measurement/ various lightning arresters.

AIM OF THE EXPERIMENT

Study of Ferranti Effect**.**

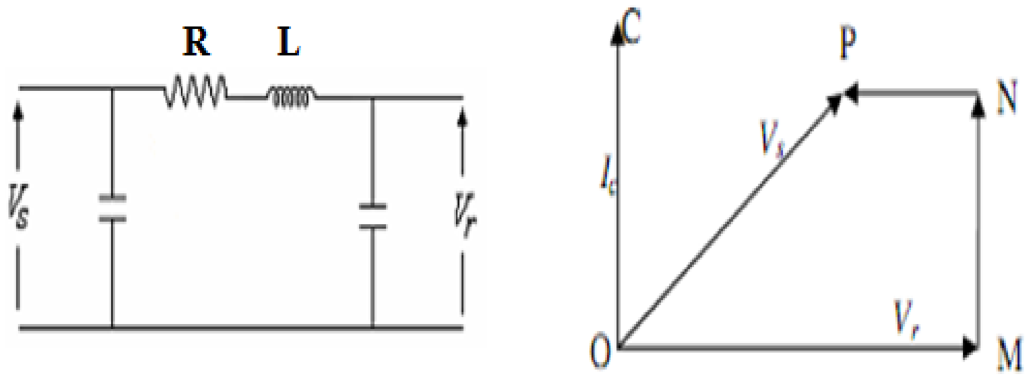
APPARATUS REQUIRED

High Voltage Transmission Line Analyzer Model.

THEORY:

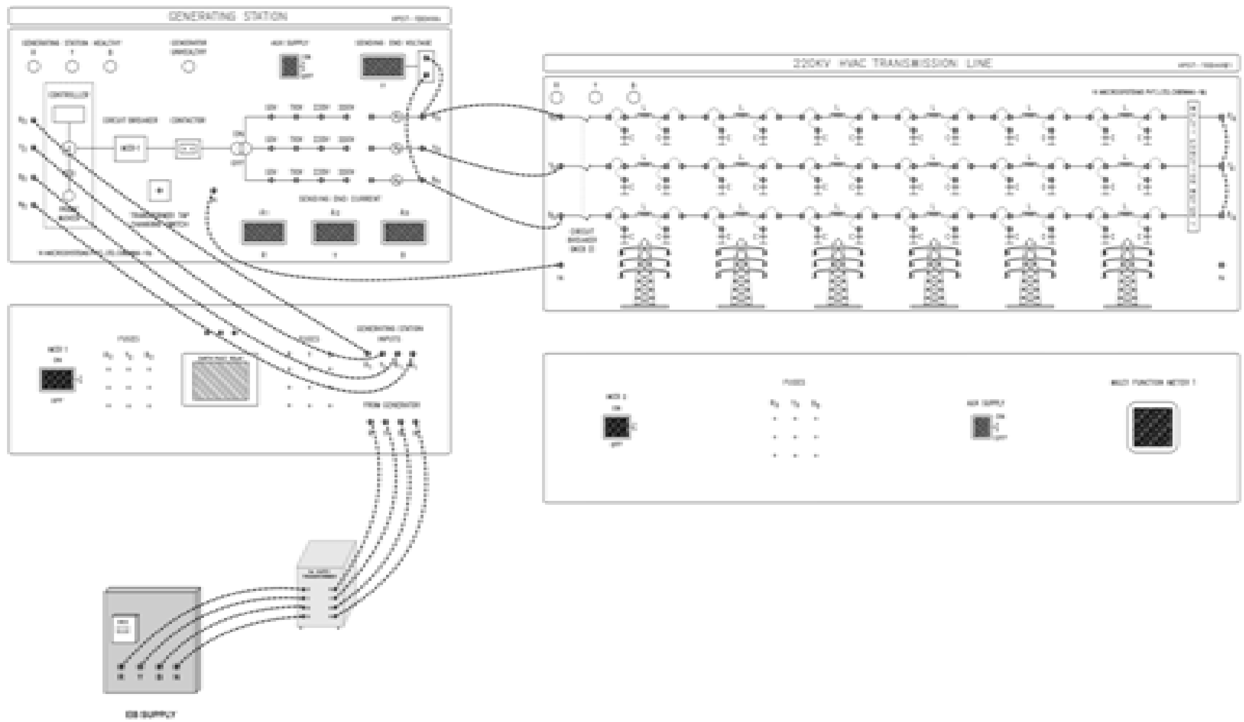
In electrical engineering, the **Ferranti effect** is an increase in voltage occurring at the receiving end of a long transmission line, above the voltage at the sending end. This occurs when the line is energized, but there is a very light load or the load is disconnected.

A long transmission line can be considered to compose a considerably high amount of capacitance and inductance distributed across the entire length of the line. Ferranti Effect occurs when current drawn by the distributed capacitance of the line itself is greater than the current associated with the load at the receiving end of the line(during light or no load). This capacitor charging current leads to voltage drop across the line inductor of the transmission system which is in phase with the sending end voltages. This voltage drop keeps on increasing additively as we move towards the load end of the line and subsequently the receiving end voltage tends to get larger than applied voltage leading to the phenomena called Ferranti effect in power system.



(Phasor diagram for Ferranti Effect)

CIRCUIT DIAGRAM:



PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Take readings during receiving end open circuited with sending end voltage 100 V.

OBSERVATION

Table – 1 for open circuit Test (Ferranti Effect)

Sl. No	Tap setting	Sending end voltage	Receiving end voltage

CONCLUSION

Assignment

1. Why Ferranti effect is not there in short transmission line?
2. What is the phase of current in the line during lite or no load condition, for medium and long transmission line?
3. Which equipment or element can reduce Ferranti effect?

AIM OF THE EXPERIMENT

Determination of ABCD Parameter.

APPARATUS REQUIRED

High Voltage Transmission Line Analyzer Model.

THEORY

When a long line is operating under no load or light load condition, shunt capacitance predominates, and then receiving end voltage is greater than the sending end voltage. This phenomenon is called Ferranti effect. This is due to voltage drop across the line inductance being in phase with the sending end voltage. Thus both capacitance and inductance are necessary to produce this phenomenon.

To obtain the ABCD parameters we need to consider the following equations.

$V_s = AV_R + BI_R$
$I_s = CV_R + DI_R$

Where ABCD are called as the transmission line parameters or chain parameters or circuit parameters.

Now by making the receiving end open circuit we can make $I_R = 0$.

$A = V_S / V_R \mid I_R = 0$ This gives A is the ratio of the voltage impressed on the line at sending end to the receiving end, when the receiving end is open circuited. It is a dimension less quantity.

$C = I_S/V_R \mid I_R = 0$ this gives C which is the ratio of the sending end current to the receiving end voltage. It is measured in mho.

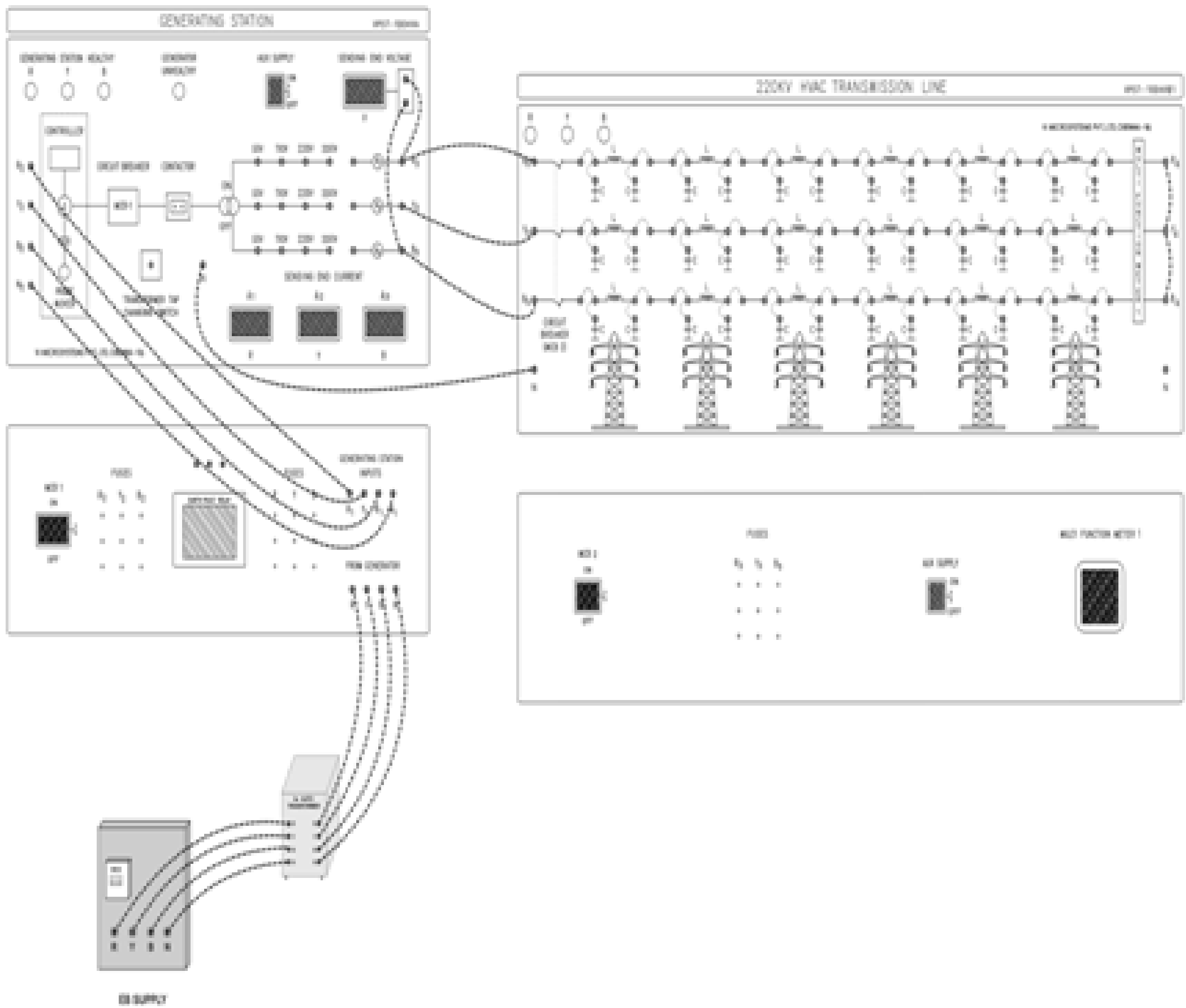
Now by making the receiving end short circuited then we can make $V_R = 0$.

$B = V_S/I_R \mid V_R = 0$ This gives the relation between the sending end voltage to receiving end current, when receiving end is short circuited. It measured in Ohm.

$D = I_S/I_R \mid V_R = 0$ This give the relation between the sending end current to receiving end current, when receiving end is short circuited. It is a dimension less quantity.

The constants ABCD are related for passive network AD-BC = 1 gives that the network is the reciprocal and A = D gives that the network is symmetrical. The π network assumes that total capacitance is divided equally at the both the ends.

CIRCUIT DIAGRAM



PROCEDURE

3. Connect the circuit as per the circuit diagram.
4. Take readings during receiving end open circuited with sending end voltage 220 V.
5. Take readings during receiving end short circuited with sending end voltage100 V.
6. Calculate A, B, C, D parameters.

OBSERVATION

Table – 1 for open circuit Test

Sl. No	Tap setting	Sending end voltage	Sending end Current	Receiving end voltage

Table – 2 for short circuit Test

Sl. No	Tap setting	Sending end voltage	Sending end Current	Receiving end Current

Table – 3 for A,B,C,D Parameters

Sl. No	Tap setting	A	B	C	D

CONCLUSION :

AIM OF THE EXPERIMENT

Shunt capacitance compensation in transmission line.

APPARATUS REQUIRED

Matlab 2020b

THEORY

SHUNT REACTOR COMPENSATION

Shunt reactors are installed at the sending end and receiving end of a long transmission line. Sometimes they are also employed at the intermediate switching sub stations to absorb the leading VARs supplied by shunt admittances during small loads or no loads.

During low loads the receiving end voltages tends increase due to effect of shunt admittance of line to reputate the voltage line to ground capacitance should be compensated. This should be done by switching the shunt reactors.

During high loads the IX_L drop increases and the voltage tends to fall below its rated value then the shunt reactors are to be switched off.

SHUNT CAPACITOR COMPENSATION

They are usually connected at the receiving end to provide leading VAR i.e., to compensate the lagging VARs during heavy loads i.e., shunt capacitors should be switched in.

Shunt capacitors are switched in when KVA demand the reactive power increase and voltage of the receiving end gets reduced. The switching of the capacitors increase the voltage at the receiving end. Thus it improves the power factor and voltage region, saves energy due to reduction of line losses, reduces KVA demand, reduces line current.

SERIES REACTOR COMPENSATION

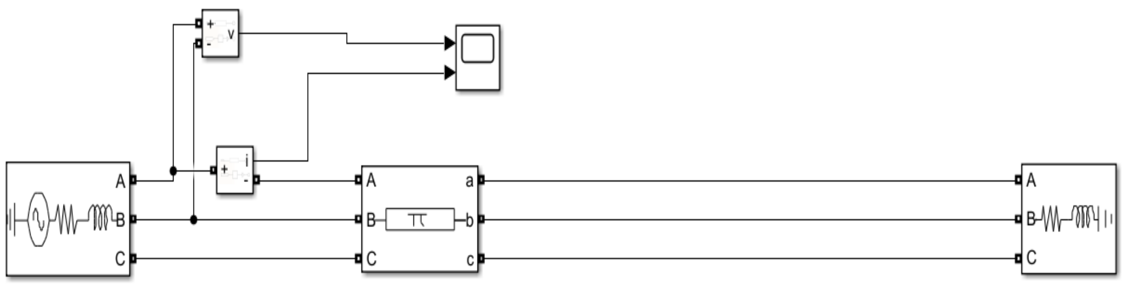
The series reactors are connected in series with the power system to reduce the fault current. These reactors can be connected at anywhere in the power system. There are reactors which can be connected at the generator ends called generator reactors for the protection from fault current. Similarly there are reactors for the transformer protection and also transmission line protection.

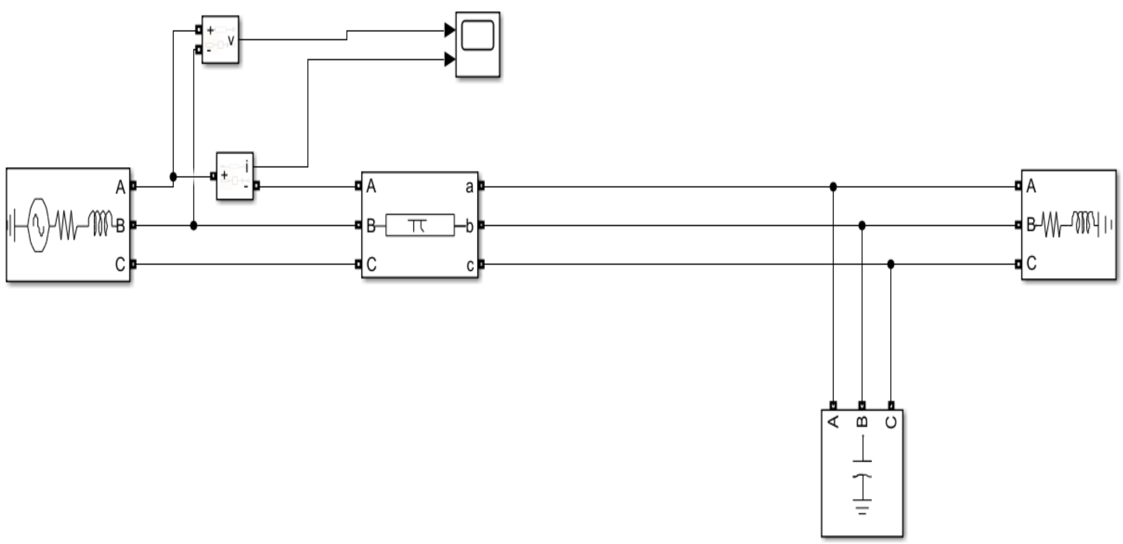
The reactor is nothing but a huge amount of inductor which can with stand huge fault currents.

LOAD COMPENSATION

When the load on the system changes the voltage at the consumer’s side changed. This is undesirable at the consumer’s side. To rectify this problem load compensation technique is used by using autotransformer. When the voltage level below the rated value, we adjust the autotransformer tappings and maintain the voltage level nearly constant.

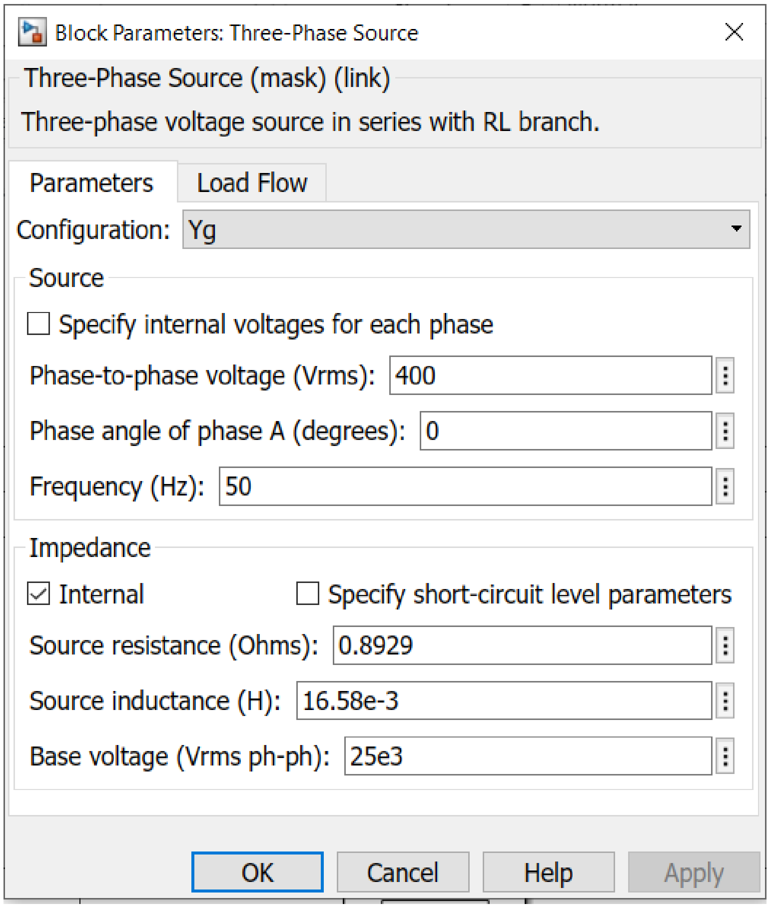
CIRCUIT DIAGRAM :



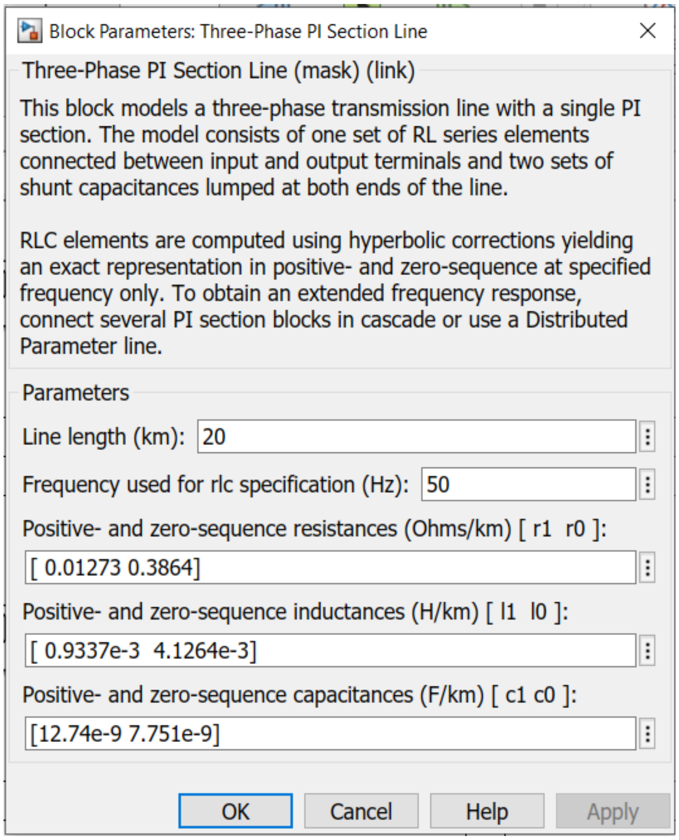


PARAMETERS

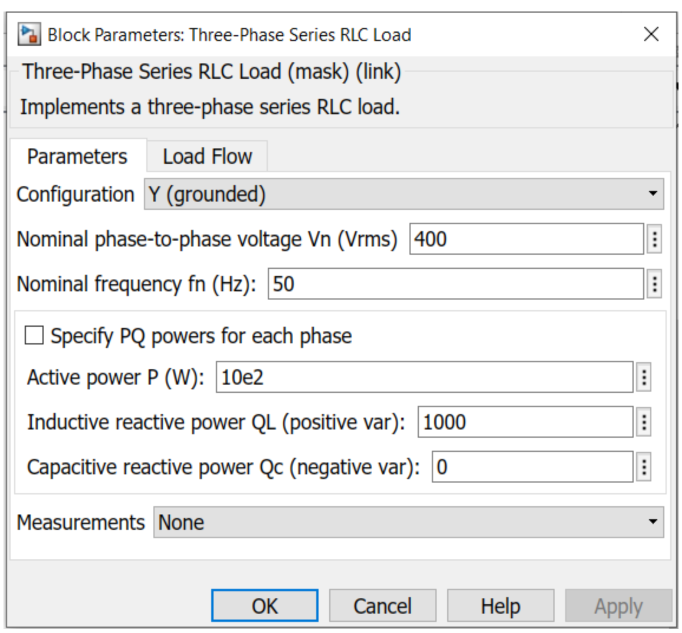
Source:



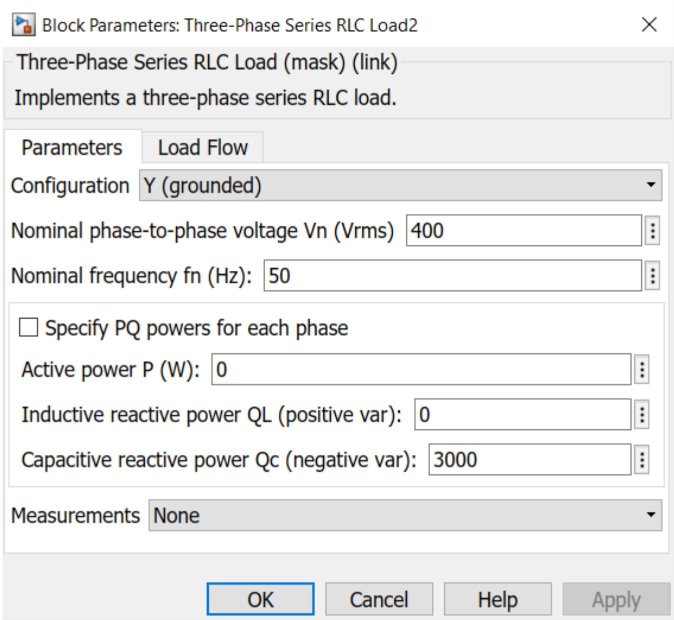
Transmission line:



Load parameter:



Capacitor parameter:



CONCLUSION

AIM OF THE EXPERIMENT

Shunt capacitance compensation in transmission line.

APPARATUS REQUIRED

High Voltage Transmission Line Analyser.

THEORY

SHUNT REACTOR COMPENSATION

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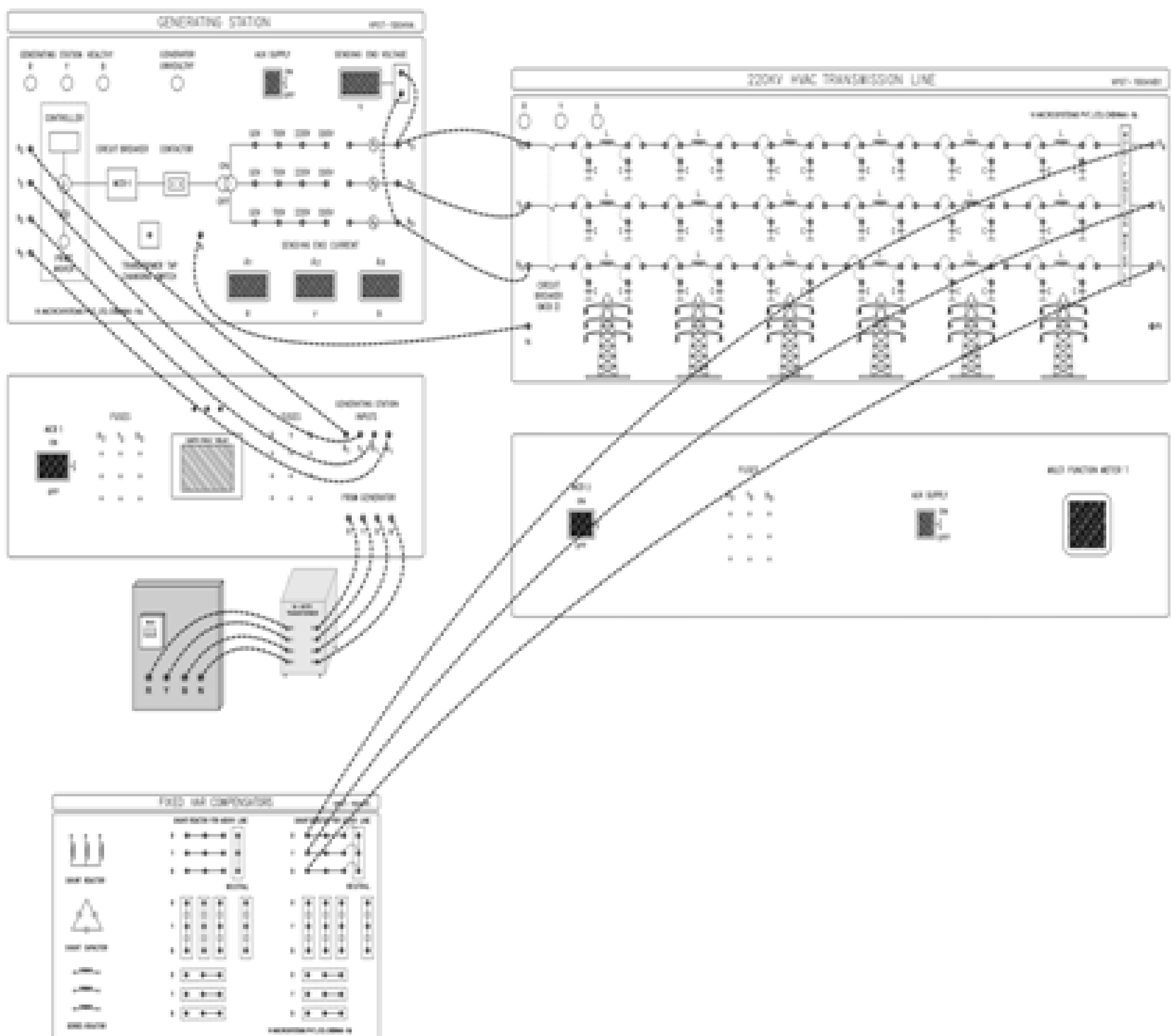
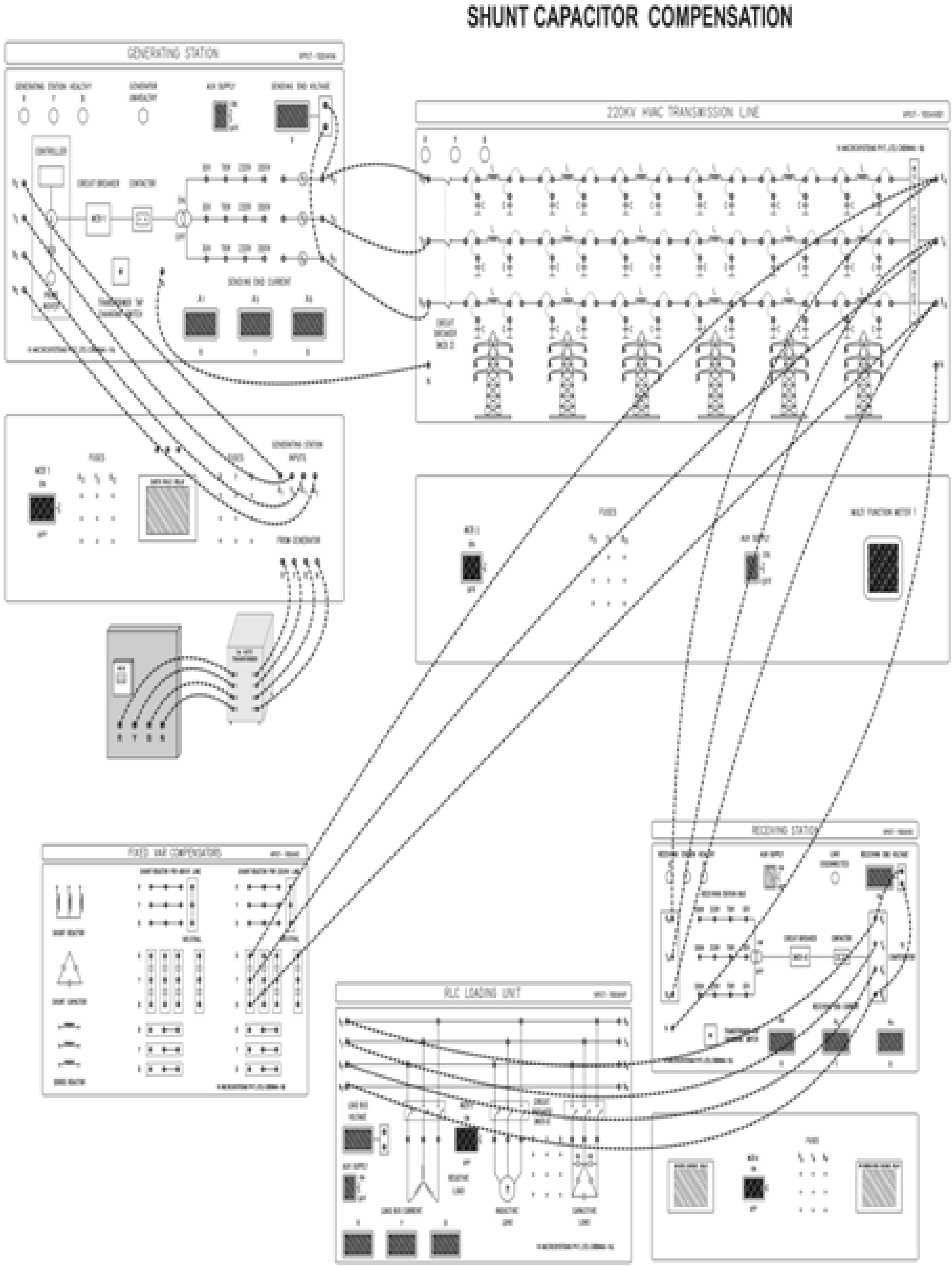
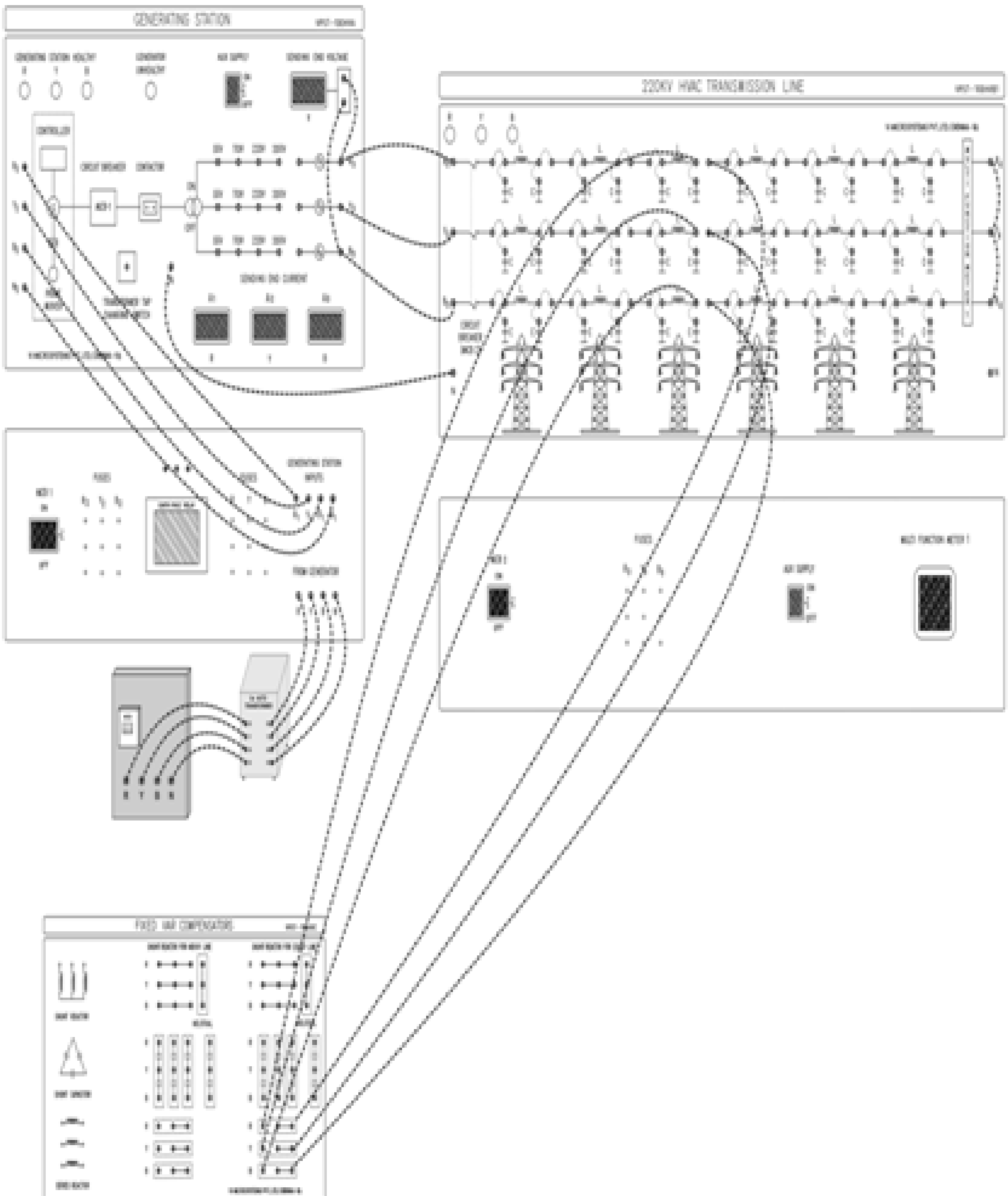
CIRCUIT DIAGRAM

SHUNT REACTOR COMPENSATION

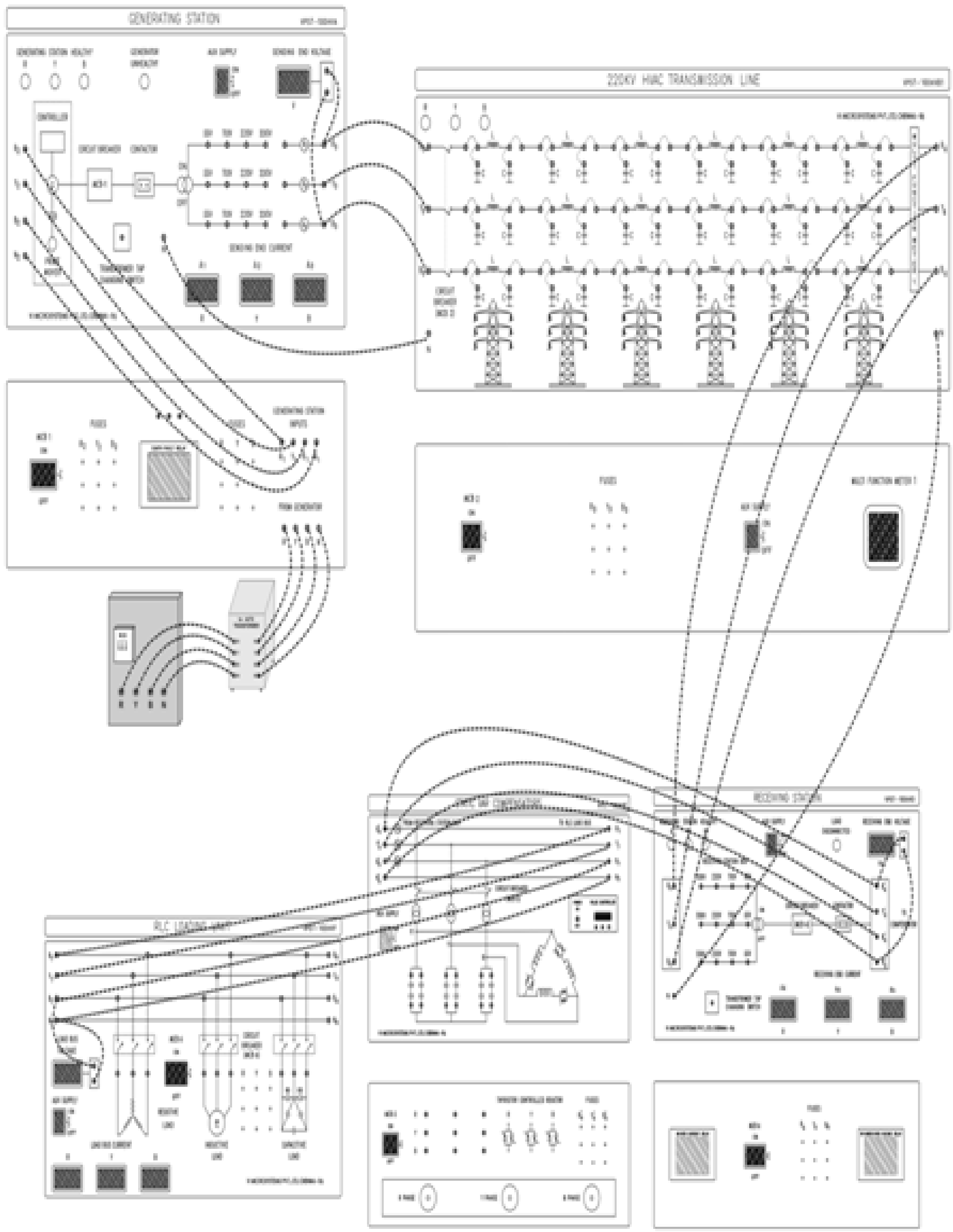



SHUNT CAPACITOR COMPENSATION
GENERATING STATION
220KV HVAC TRANSMISSION LINE
FIXED VAR COMPENSATORS
RECEIVING STATION
RLC LOADING UNIT

SERIES REACTOR COMPENSATION



LOAD COMPENSATION



PROCEDURE

Procedure for Shunt Reactor Compensation

- Open circuit the receiving end of line then we get the receiving end voltage is greater than that of the sending end voltage.
- Now connect one step of reactance to the receiving end in parallel and note down the reduced voltage.
- Now connect the second step of reactors and note down the still reduced voltage.

Procedure for Shunt Capacitor Compensation

- Load is applied at the receiving end and the voltage is intentionally brought down to its rated value.
- Now the shunt capacitors are increased step by step and the voltage raise is observed.

Procedure for series Reactor Compensation

- A 3ϕ symmetrical fault is eventually created and the fault current is measured.
- Now by adding single step of reactor the fault current is measured it is found to be low.
- Now another step is connected and fault current is found to be still reduced.

Procedure for Load Compensation

- The loading section is connected to the receiving station through static VAR compensator.
- Now the load on the system increases,and the voltage on the system reduced. Note down the voltage.
- Connect the static VAR compensator to the loading section.(only fixed capacitor)
- Change the load on the system and automatically the voltage variations are there in the phases of the system.If the voltage level increased above the rated value switch on the TCR and adjust the firing angle, the reactive power on the system changes as well as system voltage also changes.(initially the TCR firing angle is set to 180 degree°)
- If the voltage level cannot maintained constant by TCR, by adjusting the autotransformer tappings to maintain the voltage level constant at the loading section.

OBSERVATION

Table-1

For Shunt capacitor Compensation

Sl. No	Load Data	Sending end Voltage	Receiving end Voltage without compensation	Value of Shunt Capacitor	Receiving end Voltage with compensation

CONCLUSION

AIM OF THE EXPERIMENT

Distribution system power factor improvement using switched capacitor.

APPARATUS REQUIRED

High Voltage Transmission Line Analyser.
Wattmeter :- (0-600) V, (0-5-10) A -2 nos.

LOAD SPECIFICATION

Resistive load: 3-ph, 415 V, 1.5KW, 2A
Inductive load: 3-ph, 415V, 0.75 KW, 1.9 A, cosø-0.75

THEORY

Power factor is the ratio of working power to apparent power. It measures how effectively electrical power is being used. A high power factor signals efficient utilization of electrical power, while a low power factor indicates poor utilization of electrical power. To determine power factor (PF), divide working power (KW) by apparent power (KVA). In a linear or sinusoidal system, the result is also referred to as the cosine θ.

PF = KW/KVA= cosine θ, where θ= the angle between voltage & current phasor.

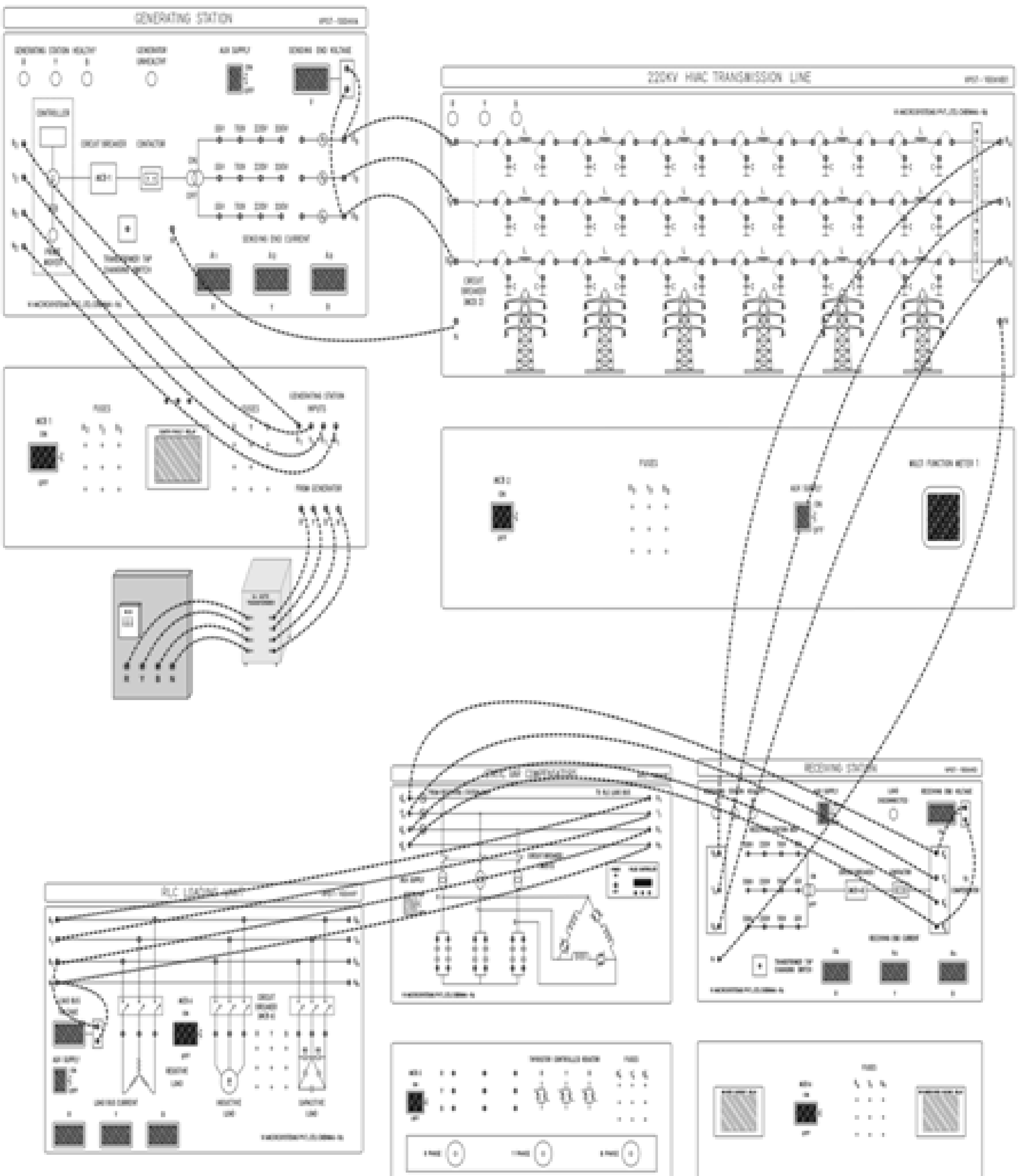
Power factor correction is achieved by the addition of capacitors in parallel with the connected motor or lighting circuits and can be applied at the equipment, distribution board or at the origin of the installation. Static power factor correction can be applied at each individual load by connecting the correction capacitors to the load.

A disadvantage can occur when the load on the motor changes and can result in under or over correction. Static power factor correction must not be applied at the output of a variable speed drive, solid state soft starter or inverter as the capacitors can cause serious damage to the electronic components.

Care should be taken when applying power factor correction star/delta type control so that the capacitors are not subjected to rapid on-off-on conditions.

CIRCUIT DIAGRAM

LOAD COMPENSATION



PROCEDURE

Procedure for power factor improvement:

- The R-L loading section is connected to the receiving station through the wattmeter.
- All the instruments readings are noted down.
- The power factor is calculated based on the instrument readings.
- The R-L-C loading section is connected to the receiving station through the wattmeter.
- All the instruments readings are noted down.
- The power factor is calculated based on the instrument readings.
- Repeat the above procedure for different loads.

OBSERVATION

Table For power factor improvement:

Sl. No	Load Data R-L in KW	Load Data C	Sending end Voltage in V	Receiving end Voltage in V	Receiving end current in A	Wattmeter reading in WATT(W_1)	Wattmeter reading in WATT(W_2)	PF (cosø)

CONCLUSION

AIM OF THE EXPERIMENT

To determine experimentally flash over voltage of given samples of transformer oil and
Hence determine their dielectric strength.

APPARATUS REQUIRED

1. Transformer oil testing kit.
   Output: 0 - 60 KV
2. Transformer oil.

SPECIFICATION

Input: 230/240 Volts 1Ph 50 Hz AC
Output: 0 - 60 KV Centre Tap Earthed
Capacity: 600 VA

THEORY

Dielectric strength has the following meanings: Of an insulating material, the maximum electric field that a pure material can withstand under ideal conditions without breaking down (i.e., without experiencing failure of its insulating properties).

Dielectric strength of transformer oil is also known as breakdown voltage of transformer oil or breakdown voltage of transformer oil. Breakdown voltage is measured by observing at what voltage, sparking strength between two electrodes immerged in the oil, separated by specific gap. Low value of break down voltage indicates presence of moisture content and conducting substances in the oil. Minimum breakdown voltage of transformer oil or dielectric strength of transformer oil at which this oil can safely be used in transformer, is considered as 30 KV/mm.

Oil test set is an equipment-designed and produced to test the dielectric strength of liquid Insulating materials such as Transformer Oil, Capacitor Oil etc.

PROCEDURE

1. The given transformer oil sample is poured into the test cup provided.
2. The gap between electrode is adjusted to the standard values by rotating one of the electrodes.

3. Power supply switch is put in ON position.
4. The HT ON push button switch is pressed.
5. The HT voltage is raised by pressing the raise push button the deserved HT voltage is reaches when a flash over occurs across the electrodes.
6. As soon as the flash over occurs, the supply to the HT transformer will be cut off automatically and voltmeter point will stop indicating the flash over voltage.
7. The experiment is repeated again for some other gap distance and means value of flash over voltage is noted.

TABULATION

Sample	Flash overt voltage in KV		Dielectric strength in KV/mm	Mean kV/mm
	Gap distance = 2.5 mm	Gap distance = 4 mm		

CALCULATIONS

Dielectric strength in KV/mm **= (**Flash overt voltage in KV) / (Gap distance in mm)

CONCLUSION

AIM OF THE EXPERIMENT

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