Daffodil International University
Department of Electrical and Electronic Engineering
EEE 458, Power System Protection Laboratory

Experiment No: 01

Name of the Experiment: Study of under frequency over frequency protection.

Theory: Due to faulty Governor of Prime mover or over load, line frequency to be change. In this reason, specially connected motor and inductive load can be damage. Excepting fixed frequency range, under frequency over frequency protection module isolate the load and save them. Under frequency over frequency protection module's relay allow to connect load only the allowed able range of frequency.

Apparatus:

1. Power supply
2. DC Motor/Generator
3. Synchronous Motor/Generator
4. DC voltmeter 3 nos.
5. Under frequency over frequency protection module

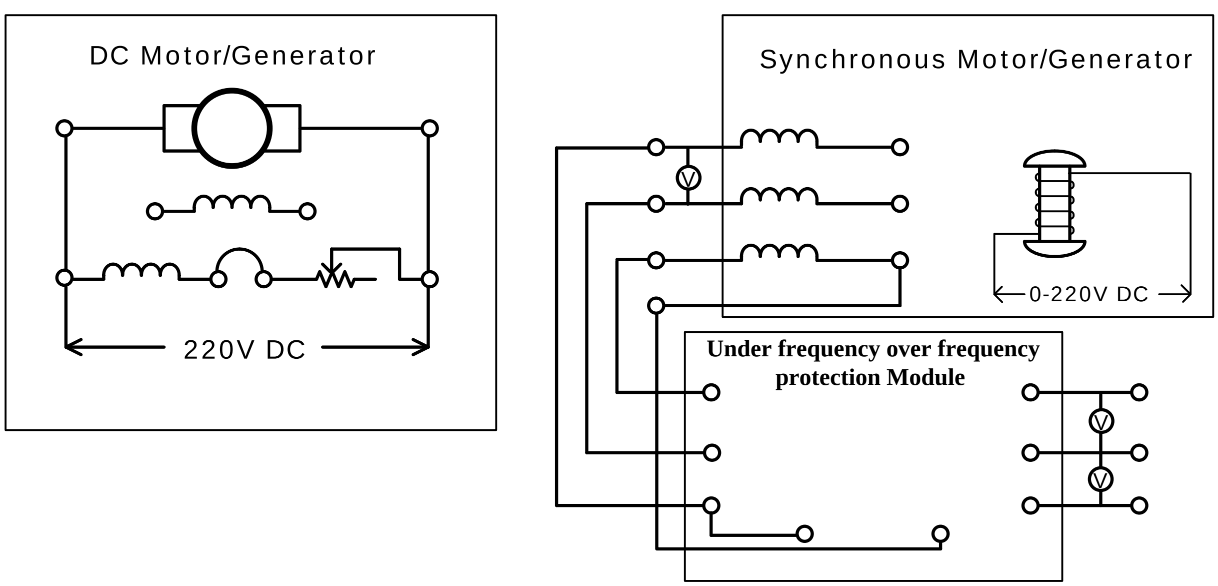


FIGURE -1

Procedure :

1. Connect the circuit shown in figure -1.
2. Turn on the power supply.
3. Set the prime mover speed near about 1500 rpm.
4. Gradually increase the rotor excitation that the terminal voltage of the alternator near about 400 volts (L-L).
5. Set the shunt field rheostat of the prime mover at it minimum position for minimum speed.
6. Gradually increase the prime mover speed by varying the shunt field rheostat.
7. Measure and record the speed when the line on.
8. Again the increase the prime mover speed up to line cut off.
9. Measure and record the alternator speed.
10. Decrease the prime mover speed by varying the shunt field rheostat up to line on again.
11. Measure and record the alternator speed.
12. Decrease the prime mover speed up to line cut off.
13. Measure and record the speed. (This cut off for under frequency).

Calculate the range of line on frequency and cut off frequency by using the formula

$$f = \frac{NP}{120}$$

Where, f = frequency of the generated voltage
N = revolution / min
P = Number of pole

Daffodil International University
Department of Electrical and Electronic Engineering
EEE 458, Power System Protection Laboratory

Experiment No: 02

Name of the Experiment: Study of Alternator synchronization with phase sequence protector.

Theory : A vital condition of alternator synchronization is bus-bar phase sequence and incoming alternator phase sequence must be same. If both phase sequence are not be same there would be occur a mechanical damage. If both phase sequence may not be same the module do not supply the power to output side of the module. The module also maintain a particular phase sequence (ABC). If the phase sequence of both side are not ABC sequence the module do not allow to energies it magnetic contact.

Apparatus:

1. Power supply
2. DC Motor/Generator
3. Synchronous Motor/Generator
4. AC voltmeter
5. Synchronizing module

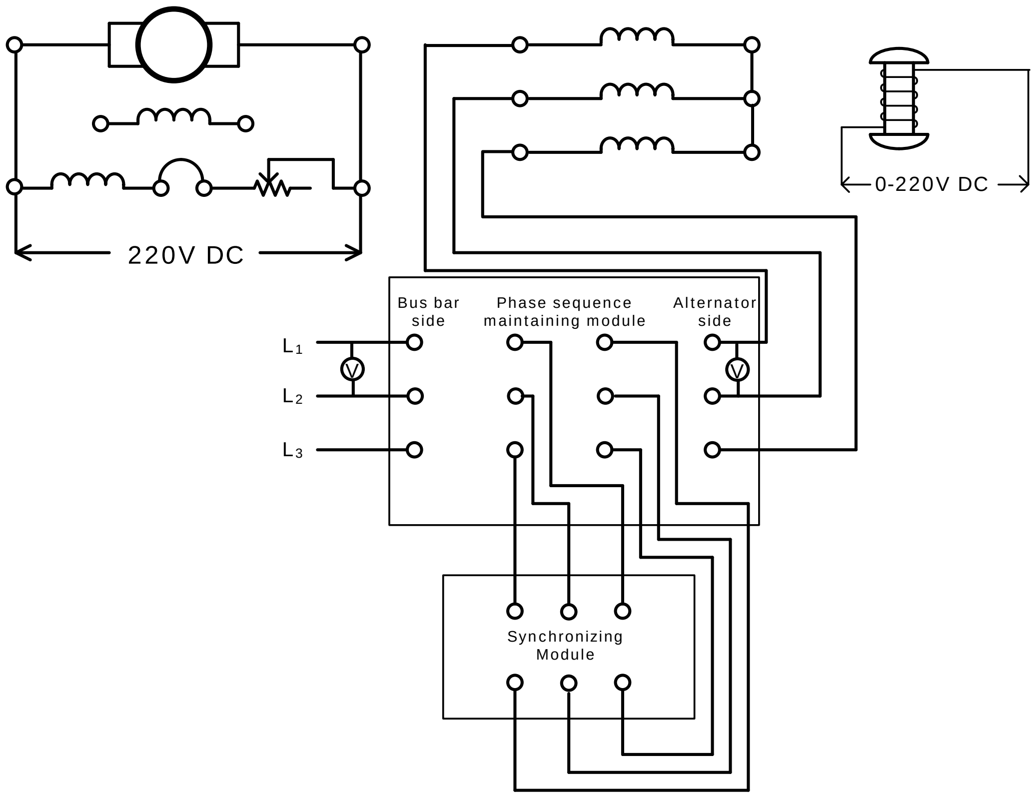


FIGURE -2

Procedure :

1. Set the circuit shown in figure (2).
2. Turn on the power supply. **(**If the indication lamp of the bus-bar side do not on, the sequence is not ABC sequence. In that case turn off the power supply and inter change two terminals and again turn on the power supply).
3. Set the prime mover (DC Motor) speed near about 1500 rpm.
4. Gradually increase the Generator excitation that the terminal voltage is equal to bus-bar voltage. (if the indication lamp of the alternator side do not on decrease the excitation of the alternator at it minimum position by varying voltage control knob of the power supply and inter change two terminals and gradually increase the excitation that the terminal voltage is equal to bus-bar voltage).
5. Gradually tune the prime mover speed that the three lamps are stable in dark condition.
6. Finally adjust the terminal voltage of the alternator by varying excitation.
7. Close the switch of the synchronizing module.

Daffodil International University
Department of Electrical and Electronic Engineering
EEE 458, Power System Protection Laboratory

Experiment No: 03

Name of the Experiment: Study of operation of Auto-re-closer.

Theory : Cause of any temporary fault of over head transmission line, the auto re-closer module re-connect the line with source automatically after remove the fault. when any fault occur in over head line the circuit breaker break the circuit instantly. Auto re-closer try to reclose the circuit after reclosing duration. If further it found faulty starts, auto re-closer break the line again. After setting numbers of trying if it found previous status continuing the auto re-closer will be shut down permanently.

Apparatus:

1. Power supply
2. Auto reclosing module

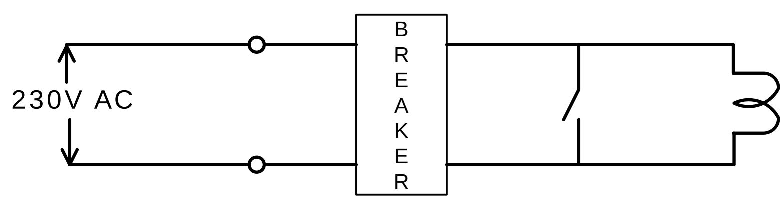


FIGURE -3

Procedure :

1. Set the circuit shown in figure (3).
2. Set the duration of re-closing timer 10-20 seconds.
3. Decide the time of re-closing (3-10)
4. Set the shut down time as following duration of re-closing times of re-closing + 1 second.

5. Turn on the power supply.
6. Turn on the Auto re-closer breaker.
7. Wait for re-closing duration to get power in load lamp.
8. Create a short circuit by closing switch S.
9. Wait for shut down time. Write down what happened cause of permanently shut down, the siren can be
10. Turn off the Auto re-closer breaker and switch S.
11. Repeat the procedure 6, 7 and 8.
12. Being Failure to start the line in first time then the switch 'S' turn off.
13. Note not happened.
14. Record the time from off the switch 'S' to closing the time
15. Again being failure to start the line in second time then the switch 'S' turn off.
16. Note what happened and record the closing time.

Daffodil International University
Department of Electrical and Electronic Engineering
EEE 458, Power System Protection Laboratory

Experiment No: 04

Name of the Experiment: Study of Transformer over heat protection by using thermal sensor.

Theory: Due to over load, short circuit or any other abnormal condition Transformer oil will be over heated. Transformer over heat protection module's thermo couple set in the conservator which can sense the temperature of transformer oil. If oil temperature exited the set temperature, Transformer over heat protection module isolates the load side.

Apparatus:

1. Power supply
2. Lamp board (load)
3. Transformer over heat protection module

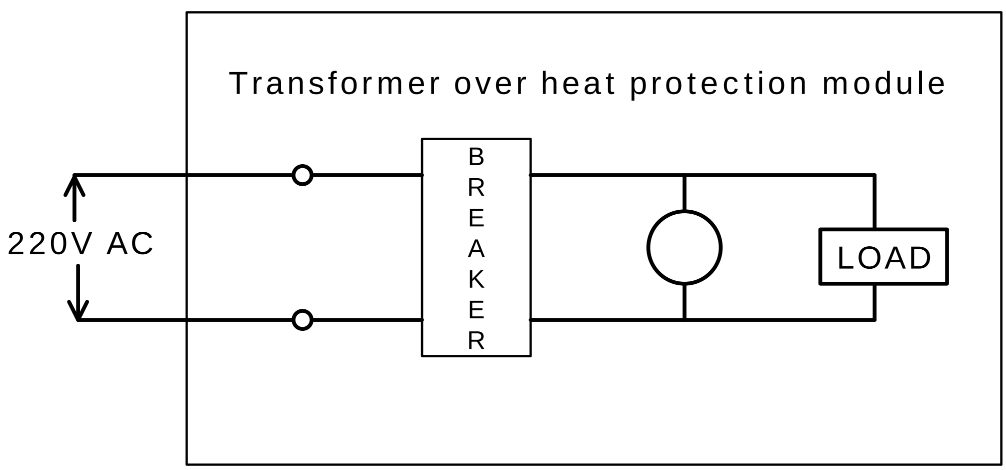


FIGURE -4

Procedure :

1. Connect the circuit shown in figure (4).
2. Set the cut off temperature in thermo sensor (more than ambient temperature).
3. Connect a load near about 100 watts.
4. Turn on the power supply.
5. Turn on the breaker of the Transformer over heat protection module.
6. Push the push button switch.
7. Increase the temperature of thermo couple by rubbing or any other way.
8. Observe and record what happened when temperature exit the cut-off temperature.
9. Again the increase the prime mover speed up to line cut off.
10. Measure and record the alternator speed.
11. Decrease the prime mover speed by varying the shunt field rheostat up to line on again.
12. Measure and record the alternator speed.
13. Decrease the prime mover speed up to line cut off.
14. Measure and record the speed. (This cut off for under frequency).

Daffodil International University
Department of Electrical and Electronic Engineering
EEE 458, Power System Protection Laboratory

Experiment No: 05

Name of the Experiment: Study of Microprocessor Controlled Power Factor Improvement (PFI) Plant

Introduction:

For fixed power and voltage, the load current is inversely proportional to the power factor. Lower the power factor, higher the load current and vice-versa. At lower power factor the KVA rating of the equipment has to be increased, making the equipment larger and expensive. Moreover, if an amount of power is distributed at low power factor line losses increases and also to cater for greater current conductor size has to be increased Therefore, low power factor is not allowed in supply systems.

The low power factor is mainly due to the fact that most of the industrial loads are inductive and therefore take lagging currents. In order to improve the power factor, some devices taking lagging current should be connected in parallel with the load. One of such device could be capacitance. In this experiment, study will be made on a PFI plant controlled by a microprocessor activated relay where capacitor bank switches are turned ON or OFF according to the power factor such that nearly unity power factor is achieved.

Features of the microprocessor controller:

The reactive and active portions of power are continuously calculated within the control relay using the measured value of the supply voltage and current.

In the case of lagging power factor one or more control contacts of the control relay are closed after an adjustable time delay.

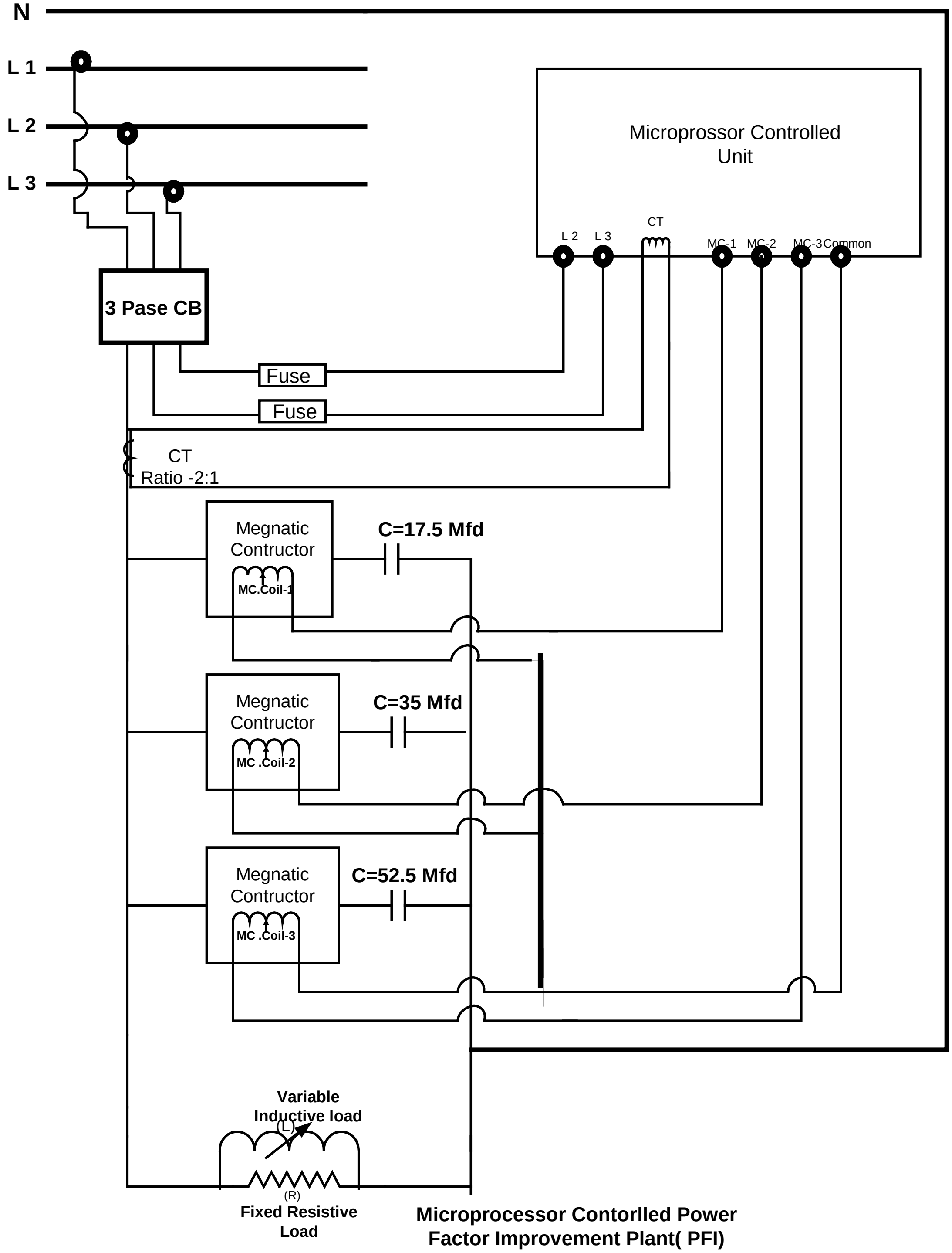
This causes the controller to switch capacitor in steps, as and when required, in order to achieve the programmed target power factor. If the inductive reactive current portion of the load is reduced, the excess of reactive current causes the capacitors to be switched off. The control relay allows a variety of possible settings to meet the condition on site.

Procedure:

1. Connect the load with the PFI plant and arrange the supply for the combination.Examine the wiring inside the PFI plant. Also notice the connections of the microprocessor relay. Draw the connection diagram of the complete set-up.

2. Vary the load and observe the switching of the capacitors. Also notice the overall power factor.

Connection Diagram:



Microprocessor Contorlled Power Factor Improvement Plant(PFI)

3. For each set of load, take reading of the load currents, overall power factor, serial no. of capacitor switched on according to the format below.

Resistive current:

Inductive current:

Total current:

Observation no	Total Current (Load)	PF (COSφ)	Ind/Cap	-C/+C	*Indicator Lamp*		
					# 1	*# 2*	*# 3*

4. Manual operation:

Press the [auto / man] button to switch to the manual mode. The “man” LED would start to blink. Press the [I_w / +] or the [I_w / --] buttons for at least 10 seconds to increase or decrease system capacitance. Press the [auto / man] button again to switch to automatic operation mode.

Report:

1. Explain the connection diagram.
2. Explain the operation of PFI plant.
3. An industry has a maximum load of 200KVA. The minimum load of the industry is half of its rated load. It is assumed that the reactive power requirement of the industry is 40% of its KVA demand. A μ-P based PFI- plant provide with a fixed base compensation together with variable compensation. The targeted power factor is 0.95. You have a 6-step switching module to switch on/off the capacitances. Design the switching sequences and the KVAR steps for optimum pf control. What would be the worst scenario with this system.