



American International University- Bangladesh

Department of Electrical and Electronic Engineering

EEE 4227: Power System Protection Laboratory

Title: Study of the performance of a Negative Phase Sequence (NPS) relay.

Introduction:

The negative phase sequence current is generated and flows through the power system during unsymmetrical faults or unbalanced loading on the system. If the unbalanced loading or unsymmetrical faults are not removed from the power system rapidly, then this current can cause a serious damage to the rotating machineries due to excessive heating of the rotor winding and rotor body.

The negative phase sequence component produces a stator magnetic flux that has the same rotational speed as the motor flux but in the opposite direction. This flux is cut by the rotor at twice the rotational speed and induces a double frequency current in the rotor winding and body in the opposite direction.

If this double frequency negative phase sequence current is allowed to persist, the excessive heat produced in the rotor body and winding could damage the machine. A negative phase sequence (NPS) relay is used to detect the unbalanced condition in the power system. The NPS relay measures the magnitude of negative sequence current continuously. If this current exceeds a limit, the relay closes the trip circuit and the associated breaker opens its contact to isolate the power system.

Theory and Methodology:

An unbalanced load can be caused due to unequal distribution of current in the grid on account of unequal loading, unsymmetrical line-to-line short-circuits, line interruption and also switching operations.

Through the unbalanced load, negative sequence current occur in the stator, which cause higher harmonics with odd numbers in the stator winding and higher harmonics with even numbers in the rotor winding. The rotor is particularly endangered in this because the higher harmonics put extra load on the rotor winding and induce eddy currents in massive iron content of the rotor which can even lead to melting of the metal or to the destruction of the metal structure.

An unbalanced load is, however, permissible in certain limits and with regard to the thermal loading limit of the generator. In order to avoid a premature outage of the generator in case of unbalanced-load, the tripping characteristic of the negative sequence protection should be adapted to the thermal characteristic of the generator.

Basically it is established that the better the cooling of the rotor, the lower are generally the permissible negative sequence values. This is due to the fact that with better rotor-cooling the maximum permissible symmetrical load can be chosen higher, however in relation to that, an unbalanced load is permissible to a less extent. For turbo generators, the value of the permissible unbalanced load is relatively low. Usual values are approx. 10- 15 % of the load which is permissible with symmetrical load.

In case of unsymmetrical short-circuits in the grid the negative sequence protection relay normally also picks up. In order to ensure selectivity, to the extent the over load carrying capacity of the generator permits it, a tripping time longer than that of the mains protection is to be selected.

Pre-Lab Homework:

Study and clear the concept of Negative Phase Sequence relay protection characteristics.

Apparatus:

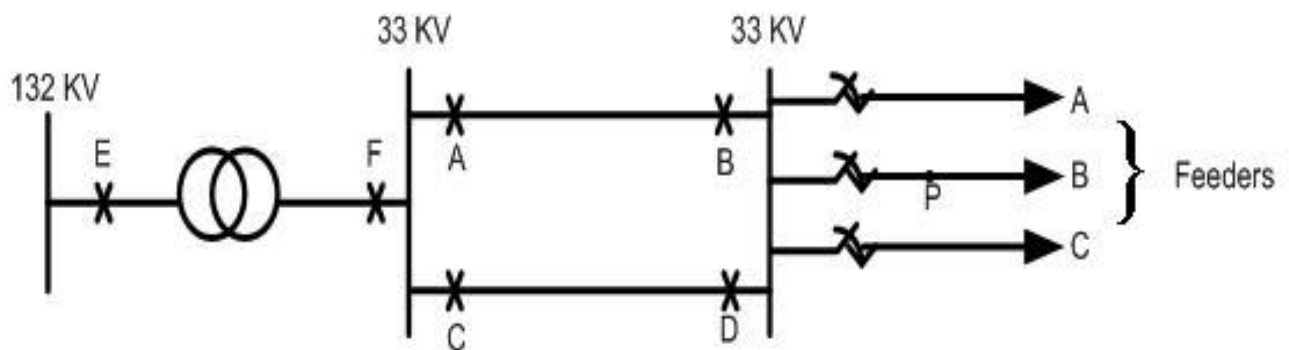
- Relay Module
- Instruction Manual

Precautions:

- Do not touch the bare conductors or connecting junctions.
- Do not switch on/off anything in the circuit without following the hierarchy.
- Be careful when power is supplied to the module and if any casing is kept open.

Experimental Procedure:

The following power system is used to observe the performance of the NPS relay.



The relays at locations B and D are directional O/C numerical relays. Only the relay at B is also set to function as NPS relay. Now one of the three phases of feeder B is opened while the feeder B is on load. Negative Sequence Current is generated in the system due to creation of unbalance in the system. The NPS relay at B picks up and trips the breaker.

Questions for report writing:

1. What are the causes of generation of negative phase sequence current in a power?
2. Can you run a power system with perfectly balanced condition all the time? Give reasons.
3. What are the electrical devices that are affected due to the presence of negative phase sequence current? Also explain the type of effect on these devices.

Reference(s):

1. “Negative Sequence Relay”, Woodward, DSF Technologies.
2. “Switchgear Protection and Power Systems” by Sunil S Rao
3. PSP previous lab sheet
4. Internet