Faculty of Information Technology

Electrical Computer Engineer Department

Power LAB (ENEE 5102)

Report of Experiment 6

"Studying the Operation of a Power Transmission Line in Condition of Ground Fault"

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Date: 11/5/2017

Abstract:

In electric power systems, a ground fault current is the abnormal electric current. In this experiment, the operation of power transmission line with neutral cable insulated is studied in the condition of ground fault. Furthermore, the power transmission line is studied in the case of installing compensated neutral conductor (Peterson coil) when there is a ground fault in the system.

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Theory:

The electric faults are the abnormal conditions of currents due to certain reasons, such as equipment failures (failures in transformers for example), or environmental conditions, or human errors. These faults usually disrupt the power supply of the system and may cause serious damages to equipment of the grid. There are various types of faults in electric systems such as [1]:

- Three phase clear of earth.
- Three phase to earth.
- Phase to phase.
- Single phase to earth.
- Two phase to earth.
- Phase to phase plus single phase to earth.

Power transmission line with neutral cable insulated in condition of ground fault:

The single line to ground fault of an electric system can occur if one of the conductors becomes in contact with the neutral conductor or drops to the ground. This can occur due to many causes such as, falling of a tree or high speed wind [2]. The fault current is closed by the ground capacitance of the phases, which is defined as C_E. Insulating the overhead transmission lines by insulating the neutral conductors can offer many advantages such as, the ground voltage is reduced in medium voltage and high voltage faults, and the operation continuity is improved since the arc is suppressed automatically in the system. On the other hand, there exist various disadvantages in these configurations which are: difficult troubleshooting, increasing the voltages. [3]

In Figure 1, a schematic representation of the three phase system showing the neutral conductor and the case of a single line ground fault.

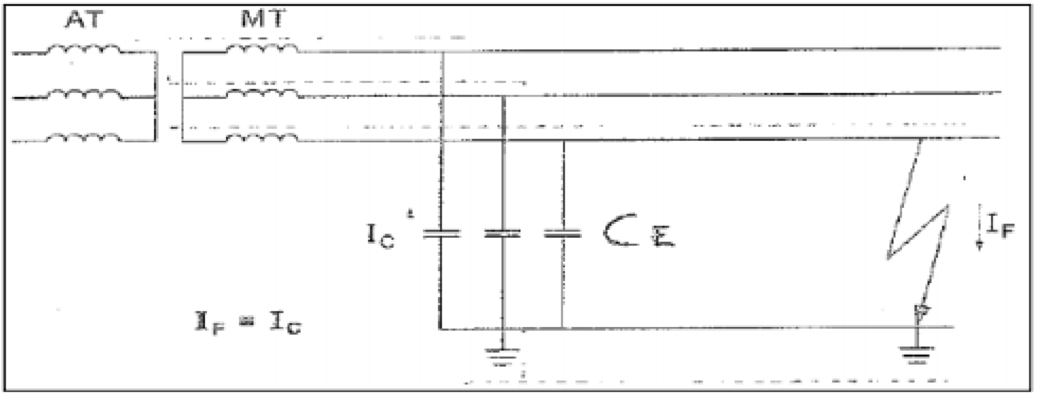

Figure 1: Schematic representation for the three phase system representing the neutral conductor and the single line ground fault.

It is noticed that as the ground capacitance C_E increases, the single line ground fault current will increase. One alternative to the neutral capacitance is the use of grounding the cable through a coil which is called Peterson coil.

Power transmission line with compensated neutral conductor (Peterson coil) in condition of ground fault:

This method is done by insulating the neutral conductor by grounding this neutral conductor by a coil, this method is an alternative to the previous one, Figure 2 represents the peterson coil scheme.

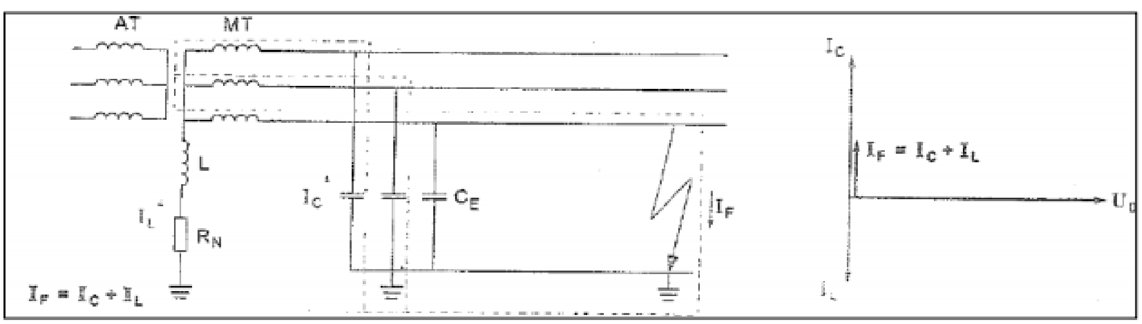

Figure 2: The operating principle of Peterson coil.

R_N is the ground resistance, CE represent the ground capacitance of each coil. The fault current will result from adding the current IL which passes through the coil and IC which passes through the capacitances of the phases, which closes the circuit path by passing through other capacitances of the lines which are not affected by the fault.

Procedure:

Part A: Power transmission line with neutral cable insulated in condition of ground fault

The circuit shown in figure 3 was connected, then the measuring instruments were connected, after that the jumpers of the both set of capacitors were connected to reproduce the capacitance between active conductors and ground equal 0.1uF -called CE. Then a short circuit was made on the right busway between line1 and ground, then the power supply with 380 V was connected to the transformer then to the grid. The set of capacitors C_E were modified, and then the table 1 was fill.

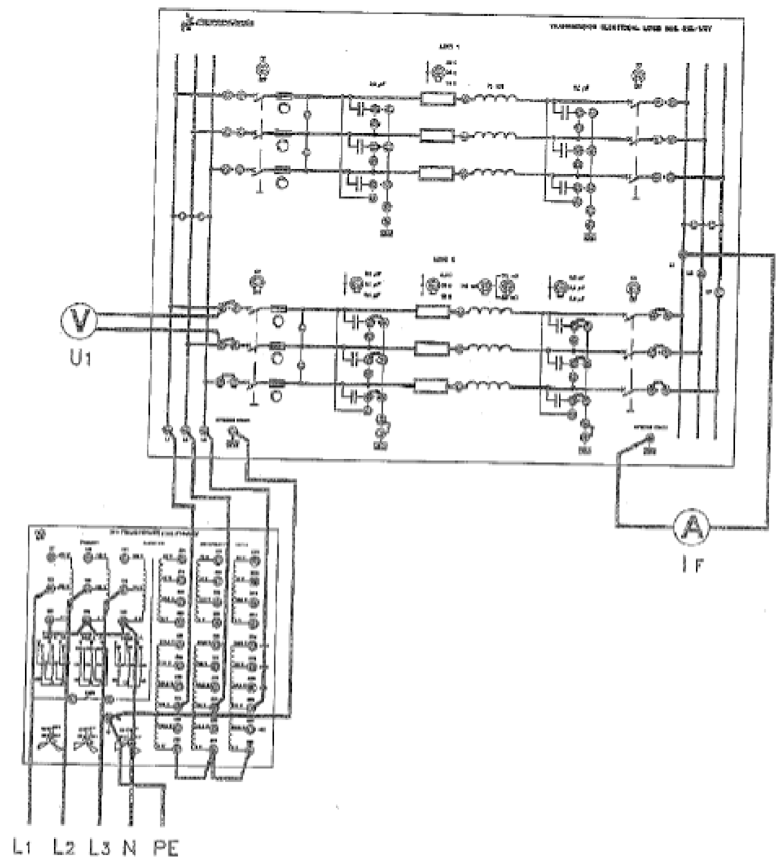

Figure 3: Detecting the ground fault current in a line with insulated neutral conductor.

PART B: Power transmission line with compensated neutral conductor (Peterson coil) in condition of ground fault

The circuit shown in figure 4 was connected The circuit shown in figure 1 was connected, then the measuring instruments were connected, after that the jumpers of the both set of capacitors were connected to reproduce the capacitance between active conductors and ground equal 0.1uF -called CE. Then a short circuit was made on the right busway between line1 and ground without any resistor connected in series with this fault line., then the power supply with 380 V was connected to the transformer then to the grid. The set of capacitors C_E were modified, and then the table 2 and 3 were fill.

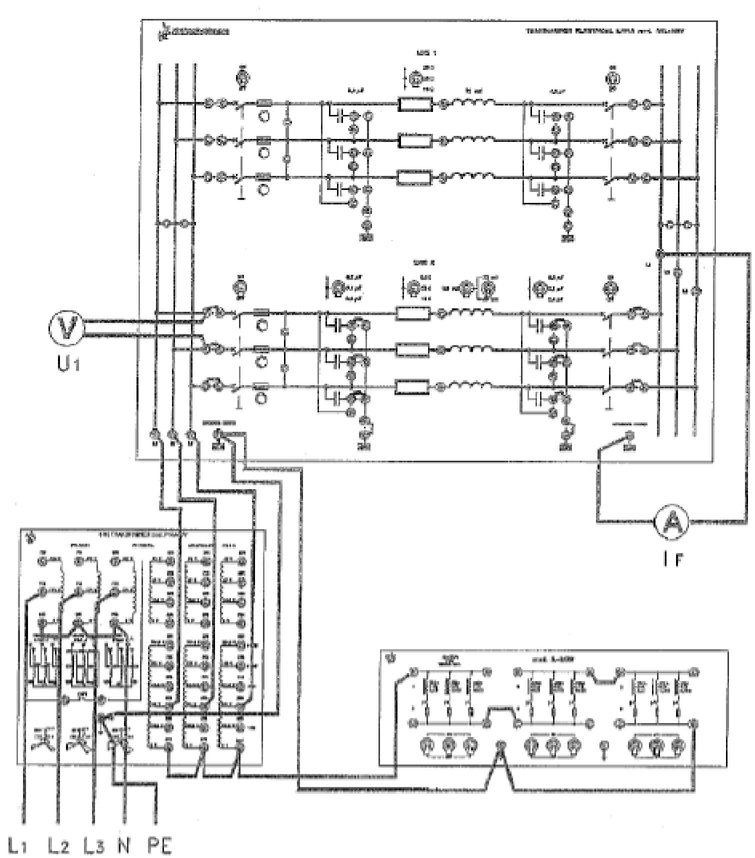

Figure 4: Detecting the ground fault current in a line with compensated neutral conductor.

Results and Discussion:

Part A: Power transmission line with neutral cable insulated in condition of ground fault

It's clearly shown from table (1) that the increasing in the capacitor value increase the fault current that because the charging current will increase and it was discharged during the fault.

C_E sending C_E receiving (μF)	Sending Voltage V_s(V)	Free ground fault current I_F (A)	Trend fault current at sending end $I_{F,S}$(A)	Trend fault current at receiving end $I_{F,R}$(A)
0.1 , 0.1	380	0.016	0.046	0.046
0.1 , 0.2	380	0.023	0.069	0.068
0.1 , 0.4	380	0.037	0.103	0.103
0.2 , 0.2	380	0.025	0.09	0.090
0.2 , 0.4	380	0.044	0.127	0.126
0.4 , 0.4	380	0.060	0.175	0.175

Table 1: Trend fault current at sending end and reciving end for different value of CE sending and receiving

PART B: Power transmission line with compensated neutral conductor (Peterson coil) in condition of ground fault.

From table (3) and (4) is shown that adding an appropriate conductance can decrease the value of the fault current. Also, it was shown that increasing the value of the conductance decrease the fault current until a specific point (resonant) then, any increasing in the inductance of the conductor increase the fault current rapidly. So, the optimal choice for the value of the conductor is the resonant value to decrease the rating of the protection device and to make the coordination more easily.

C_E sending C_E receiving (μF)	Sending Voltage V_s(V)	Conductance of compensation coil L (mH)	Trend fault current at sending end $I_{F,S}$(A)	Trend fault current at receiving end $I_{F,R}$(A)
0.4 , 0.4	380	6.9	0.088	0.088
0.4 , 0.4	380	5.75	0.073	0.075
0.4 , 0.4	380	5.18	0.066	0.068
0.4 , 0.4	380	4.03	0.055	0.060
0.4 , 0.4	380	3.46	0.063	0.065
0.4 , 0.4	380	2.3	0.127	0.129
0.4 , 0.4	380	1.74	0.218	0.220

Table 2: Trend fault current at sending end and receiving end for different value of conductance of compensation coil and CE equal 0.4

C_E sending C_E receiving (μF)	Sending Voltage V_s(V)	Conductance of compensation coil L (mH)	Trend fault current at sending end $I_{F,S}$(A)	Trend fault current at receiving end $I_{F,R}$(A)
0.2 , 0.2	380	6.9	0.028	0.028
0.2 , 0.2	380	5.75	0.037	0.038
0.2 , 0.2	380	5.18	0.050	0.050
0.2 , 0.2	380	4.03	0.081	0.082
0.2 , 0.2	380	3.46	0.111	0.112
0.2 , 0.2	380	2.3	0.192	0.192
0.2 , 0.2	380	1.74	0.284	0.285

Table 3: Trend fault current at sending end and receiving end for different value of conductance of compensation coil and CE equal 0.2

Conclusion:

In this report, the ground fault current was measured for many value of capacitance between active conductors and ground at the sending and receiving end. The result showed that the fault current was increasing as the capacitor value increases due to the increased in charging current during the fault. Also the effect of appropriate conductance was studied, since increasing the value of the conductance decrease the fault current until resonant.

References:

[1]: http://www.electronicshub.org/types-of-faults-in-electrical-power systems.

[2]: https://www.elprocus.com/what-are-the-different-types-of-faults-in-electrical-power-systems/.

[3]: Power Lab Manual, Birzite University, Ramallah, 2016/2017.

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