Physical Model And Study Of Single-Phase Short Circuit In Networks Connecting Transformer Neutral To Ground In Physical Model And Matlab Software

To'xtashev Alisher Akmaljon o'g'li
Assistant, Fergana polytechnical institute,
Uzbekistan, Fergana Region, Fergana
E-mail: toxtashev.3321@gmail.com

Eshquziev Khurshidjon Musajonovich
"Uzenergosinspektsiya" Ferghana territorial department,
Uzbekistan, Fergana Region, Fergana
E-mail: yoturk1986@gmail.com

ABSTRACT

In the article, the connection of the transformer neutral to the ground in two different ways is considered in a physical model. In these experiments, when the neutral of the transformer is connected in different ways, the change of the short-circuit current in the short-circuited phases, the change of the phase voltages, and the change of the values of the active and inductive resistance are considered in the physical model and the model in the Matlab program.

Keywords: Transformer, matlab, neutral effectively connected to earth, neutral, inductive resistance, active resistance, short circuit current, voltage deviation, single phase short circuit.

The neutral point of the electrical system is the common point of generators or transformers connected in star form.

The type of grounding of the neutrals of machines and transformers largely depends on the insulation quality of electrical systems and the choice of switching equipment, the magnitude of overvoltages and their limitation methods, the magnitude of short-circuit currents through one phase to the ground, the operating conditions of relay protection and safety in electrical networks, communications depends in many respects on the electromagnetic influence shown to the lines, etc.

Electric networks are divided into four groups depending on the operating mode of neutrals:[1,2,3]

1) networks whose neutrals are not grounded;

2) networks with neutrals resonantly connected to the ground;

3) networks whose neutrals are effectively grounded;

4) connected networks whose neutrals are not grounded.

The ground fault current has an almost pure capacitive current that can take on dangerously high amounts in common power systems. If the short-circuited phase is connected to the ground through a certain amount of inductance, the ground current is neutralized or extinguished, that is, it almost disappears. An inductance coil is called a ground-fault neutralizer or a Petersen choke coil (after its inventor).

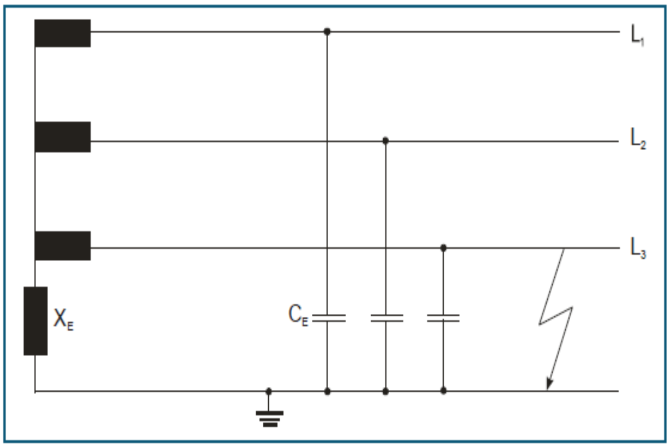


Figure 1: Earthing in a network with a neutral.

Because the grounding capacitances of the systems (connections and disconnections of the lines) change as the power changes, the Petersen inductance coil must also be variable. Because of this, in selected areas of the power system, plunger coils or branch coils are used where the neutral point connections of the transformers are connected to the grounding line.

The mathematical determination of the required inductance for neutralization can be re-implemented using only the method of symmetrical components.

The following condition applies to the reactive resistance of the earth-fault neutraliser:

$$X_E = \frac{1}{3\omega C_E} \quad (1)$$

A short circuit cannot be fully compensated because the line resistance also has an active component due to the constant presence of the line resistance. The active component is approximately 10% of the short-circuit current and is described as the unbalanced residual earth fault current.[4]

In order to reduce the grounding current of three-phase networks with neutrals resonantly connected to the ground, the neutrals are connected to the ground through an arc extinguishing coil in the 3-35 kV networks of our continent (Fig. 2) [5].

a) b) c)

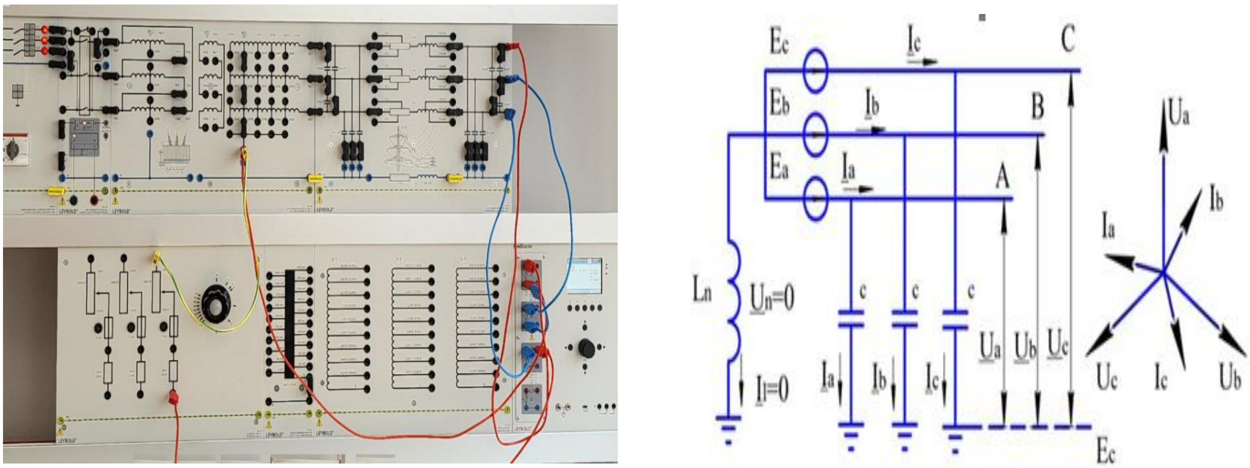


Figure-2. Three-phase networks with neutrals resonantly connected to the ground a) connection diagram of the laboratory stand b) calculation diagram of the network c) voltage vector diagram

In normal operation, practically no current flows through the coil. When it is fully connected to the phase, the coil of the arc quencher is in phase voltage, and the inductance current JL of the coil passes along with the capacitive current Js from the place of connection to the ground.

Since the inductance and capacitance currents are out of phase relative to each other by 180°, they compensate each other at the ground connection. If IS = IL (resonance), no current flows through the ground. Due to this, an arc does not form in the damaged area and the dangerous consequences associated with it are eliminated.

a) b) c)

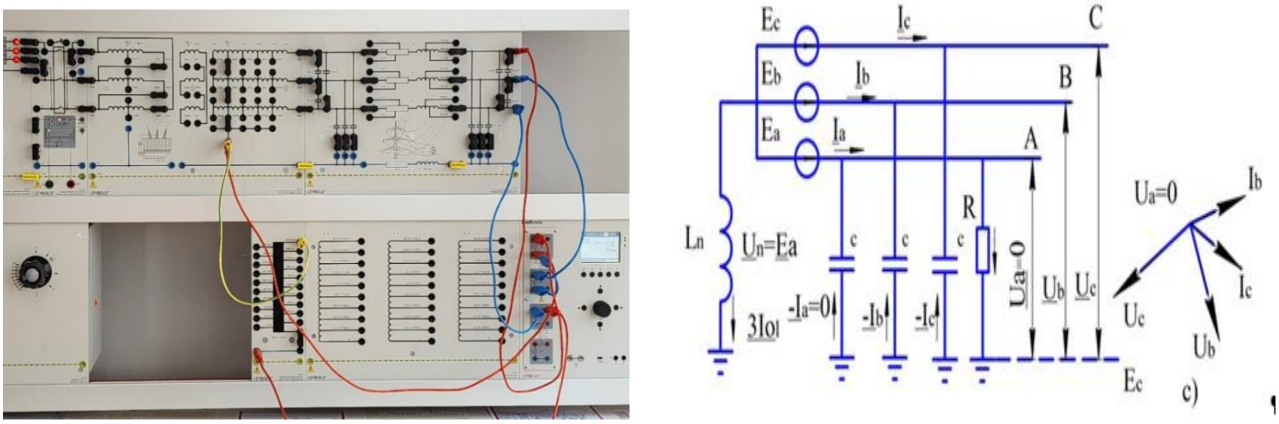


Figure-3. Three-phase networks connected to the neutral ground through a network capacitance current compensating coil a) laboratory stand connection diagram b) network calculation diagram c) voltage vector diagram

In our country, three-phase networks connected by a coil compensating the capacitance current of the neutral to the ground network are used in 220 and 380 V networks. At this time, the neutrals of all sources are grounded. In systems with a voltage of 110 kV and higher, the insulation value is a decisive factor in choosing the method of connecting the neutral to the ground. Here, effective neutral grounding is used, in which the voltage between the undamaged phases in a single-phase short circuit is approximately 0.8 of the phase-to-phase voltage in normal operation. This is the main advantage of the neutral grounding method.

Based on the above studies, in the physical model of LD-DIDACTIC GMBH and in the experiments conducted in Matlab R2017b, the phase voltage of a single-phase short circuit in the network and the effect of this phase on the phase angle were conducted in three different cases (Fig. 4) .

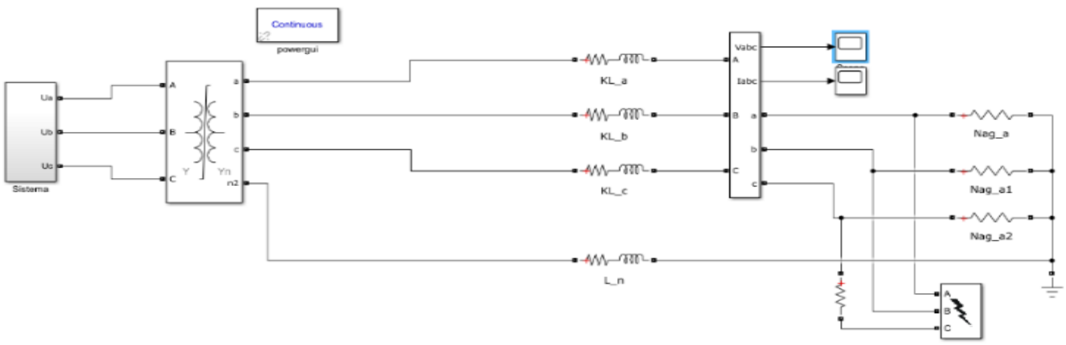
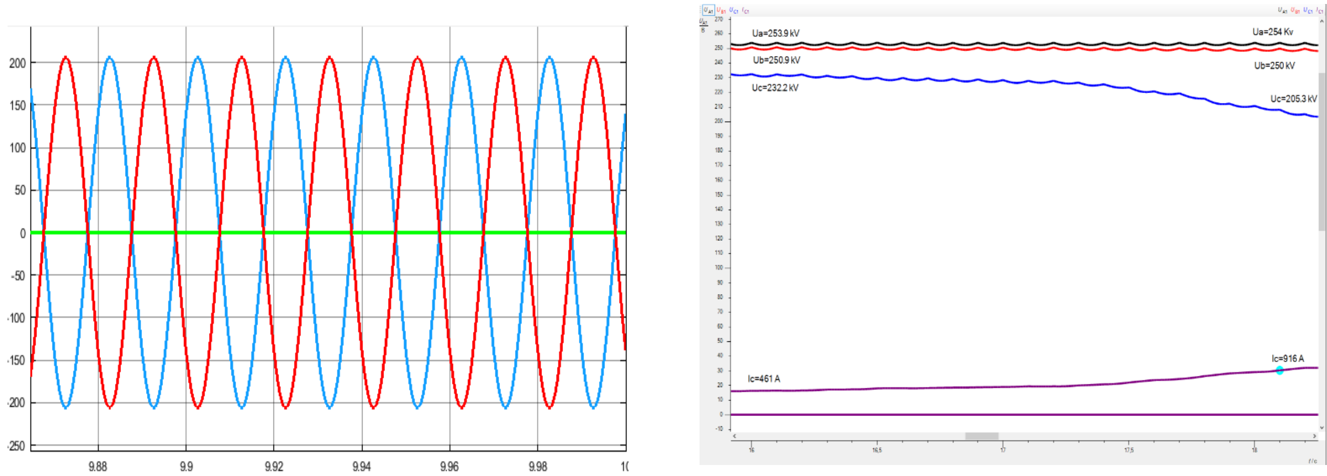


Figure-5. Scheme of the working laboratory assembled in the Matlab program

Based on the above studies, in the experiments carried out in the LD-DIDACTIC LEYBOLD physical model, the phase voltage of a single-phase short circuit in the network and the effect of this phase on the phase angle were tested in three different situations. During the initial experiment, the oscillogram of network parameters change when a single-phase short-circuit condition is created when the neutral of the transformer is connected to the ground through an active resistance is presented in Figure 5. During the same experiment, the short-circuit mode was connected with the single-phase ground through an active resistance by changing the active resistance in the range from 200 to 1000, and in this case, a significant change can be seen in the oscillogram of the network voltage change compared to the case where the transformer neutral is firmly connected to the ground. The value of the short-circuit current in the Uc phase, where the neutral of the transformer is connected to the earth through an active resistance, was 30% less than the value of the short-circuit current in the case where the neutral is firmly connected to the earth. In the experiment, the network parameters change, when the neutral of the transformer is connected through a resistance of 1000 Ohm, the value of the voltage in the short circuit phase is 239 kV, and the value of the short circuit current is 248 A. As the value of the resistance gradually decreased, the value of the short circuit current increased. At the smallest level of resistance, i.e. at 200 Ohm resistance, the value of the short-circuit current was 916 A, and the value of the voltage was 203.8 kV.



a) b)

Figure-5. a) Oscillogram of a short circuit through an active resistance with a neutral single-phase ground in the Matlab program b) An oscillogram of a short circuit with a transformer neutral single-phase ground through an active resistance obtained in the physical model

Then, in laboratory conditions, a short-circuit experiment with a single-phase ground was conducted in the case where the transformer neutral was connected to the ground through an inductive resistance. When the neutral of the transformer is connected through an inductive resistance, it can be seen that the value of the voltage on the short-circuited line decreases by 30%, while the value of the short-circuit current decreases as the value of the inductive resistance increases. 1601 A, the short-circuit phase voltage was 120.7 Kv, the largest inductance was 293 An when connected with 2000 mHn, and the short-circuit phase voltage was 211.7 Kv. During this period, the power flowing from the short-circuited phase to the ground varied in the range of 7 to 20 kW.

a) b)

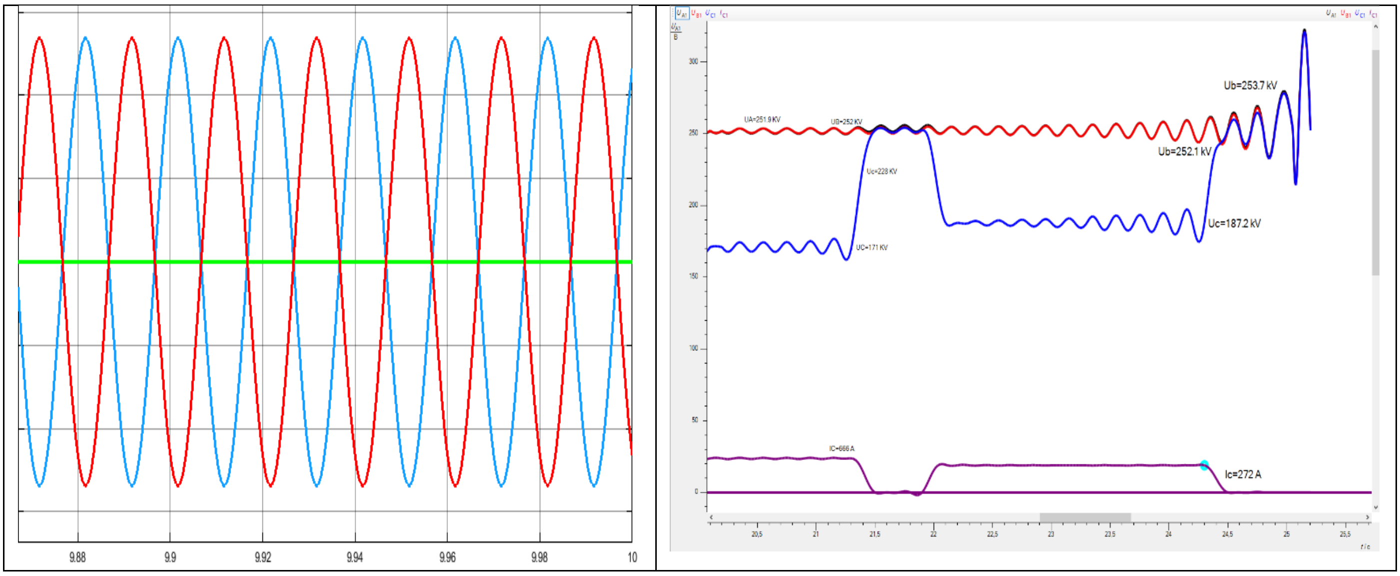


Figure 5 a) Oscillogram of a short circuit through an inductive resistance with a neutral single-phase earth in the Matlab program b) an oscillogram of a short circuit through an inductive resistance with a transformer neutral single-phase earth in the physical model

It can be seen from the conducted experiments that the change of the short-circuit current in the short-circuit phase of the power line during the short-circuit in different connection states of the transformer neutral was considered. As a result, when the transformer neutral is firmly connected to the ground, the short-circuit phase voltage becomes zero, and the value of the short-circuit current increases to 2282 A, when the transformer neutral is connected through an active resistance, the value of the short-circuit phase voltage decreases by a maximum of 20%, and the value of the short-circuit current is the smallest active resistance. In this case, we have seen that the short-circuit current is 60% less compared to the network with the neutral firmly connected to the ground. In the last experiment, the value of the short-circuit current flowing in the network was the smallest value, i.e. 330A, when the neutral of the transformer was connected to the ground through inductive resistance.

References

1. Автоматика ликвидации асинхронного режима. / Ya.E. Gonik, E.S. Gonik, E.S.Ilkitskiy, Moskva: Energoatomizdat,1988 Ю. С. Железко. Потери электроэнергии. Реактивная мощность. Качество электроэнергии : рук. для практ. расчетов /. - М.: ЭНАС, 2009. - 456 с.
2. Zoxidov Iqboljon Zokirjonovich MOYLI KUCH TRANSFORMATORLARNI KOMPLEKS DIAGNOSTIKA ZARURATI // Ta'lim fidoyilari. 2022. №Special issue. URL: https://cyberleninka.ru/article/n/moyli-kuch-transformatorlarni-kompleks-diagnostika-zarurati (дата обращения: 13.04.2023).
3. Abdullayev K. et al. PROTECTIVE PROTECTION AGAINST ELECTRIC SHOCK DURING REPAIR OF ELECTRICAL NETWORKS //Студенческий. – 2019. – №. 6-2. – С. 61-63.
4. Abdullayev A. A. et al. Asinxron dvigatellarda yuqori garmonikalar tasiridan kelib chiqqan isroflar //Involta Scientific Journal. – 2022. – Т. 1. – №. 6. – С. 278-285.
5. Исмоилов И. К., Халилова Ф. А. Регулирование активной и реактивной мощности синхронного генератора при подключении к сети //Universum: технические науки. – 2021. – №. 1-3 (82).
6. Ma'Dievna Y. S. et al. Developing reading comprehension skills of learners

//Вопросы науки и образования. – 2019. – №. 7 (53). – С. 193-195.

7. Zokhidov Iqboljon Zokirjonovich ҚИШЛОҚ ХЎЖАЛИГИ МАШИНАЛАРИНИ ЭЛЕКТРЛАШТИРИЛИШИ // Ta'lim fidoyilari. 2022. №. URL: https://cyberleninka.ru/article/n/ishlo-h-zhaligi-mashinalarini-elektrlashtirilishi (дата обращения: 13.04.2023).
8. Bokiyev A. A., Zokhidov I. Z. MOBILE ENERGY TECHNOLOGICAL TOOLS BASED ON RENEWABLE ENERGY SOURCES //INTERNATIONAL JOURNAL OF RESEARCH IN COMMERCE, IT, ENGINEERING AND SOCIAL SCIENCES ISSN: 2349-7793 Impact Factor: 6.876. – 2022. – Т. 16. – №. 09. – С. 10-15.
9. Boqiev A. A., Zoxidov I. Z. BOG'DORCHILIK VA ISSIQXONALARDA O 'SIMLIKLARGA PURKAB ISHLOV BERUVCHI ELEKTR MEXANIK QURILMA //Eurasian Journal of Medical and Natural Sciences. – 2022. – Т. 2. – №. 11. – С. 232-235.
10. Комолддинов С. С. Ў. Кодиров Афзал Ахрор Ўғли, Ашуров Абдулахад Валижон Ўғли, & Тухтасинов Саидисломхон Хасанхон Ўғли (2022) //РЕГУЛИРОВКА ИЗМЕНЕНИЯ НАПРЯЖЕНИЯ В УСТРОЙСТВЕ АВТОКОМПЕНСАЦИИ (НА ПРИМЕРЕ ОДНОЙ ФАЗЫ).,(5-9 (98)). – С. 49-54.
11. Akmaljon o'g T. A. et al. Analysis Of Dynamic Stability Of Synchronous Generators In Hydro Power Station In The Electrical Energy System In The Matlab Software //Eurasian Journal of Engineering and Technology. – 2023. – Т. 18. – С. 1-5.
12. Исмоилов И. К., Турсунов Д. А. Применение методов робастного управления в системах регулирования синхронных генераторов //Universum: технические науки. – 2020. – №. 12-5 (81). – С. 28-31.
13. Эралиев Хожиакбар Абдинаби Угли, Латипова Мухайё Ибрагимжановна, Бойназаров Бекзод Бахтиёрович, Абдуллаев Абдувохид Абдугаппар Угли, Ахмаджонов Аббосжон Эркинжон Угли Восстановление разреженного состояния в сравнении с обобщенной оценкой максимального правдоподобия энергосистемы // Проблемы Науки. 2019. №12-2 (145).
14. F.A.Xalilova. Effective Organization of Laboratory Exercises in Teaching the Science of Electrical Technical Materials in Technical Higher Education Institutions //Eurasian Journal of Learning and Academic Teaching. – 2022. – Т.. – С. 82-87.
15. F.A.Xalilova. Ta'limda zamonaviy raqamli texnologiyalaridan foydalanib "Elektr texnik materiallar" fanini o'qitishda amaliy mashg'ulotlarni samarali
tashkil etish. Academic research in educational sciences 2 (CSPI conference 3),
414-419.
16. Холиддинов И. Х. и др. АНАЛИЗ СНИЖЕНИЯ ПОТЕРЬ В ЭЛЕКТРИЧЕСКИХ СЕТЯХ ПРИ ИСПОЛЬЗОВАНИИ СОВРЕМЕННЫХ ЭЛЕКТРИЧЕСКИХ КАБЕЛЕЙ //Главный редактор: Ахметов Сайранбек Махсутович, д-р техн. наук. – 2022. – С. 26.
17. Домуладжанов Ибрагимжон Хаджимухамедович, Домуладжанова Шахло Ибрагимовна, Латипова Мухайё Ибрагимжановна, Махмудов Содир Юсуфалиевич ХАРАКТЕРИСТИКА ВОЗДЕЙСТВИЯ МИНИ - ЦЕХА КОНСЕРВАЦИИ НА ОКРУЖАЮЩУЮ СРЕДУ // Universum: технические науки. 2021. №11-1 (92). URL: https://cyberleninka.ru/article/n/harakteristika-vozdeystviya-mini-tseha-konservatsii-na-okruzhayuschuyu-sredu (дата обращения: 22.05.2023).
18. 18.Abdullaeva.M.A., . (2022). IMPROVEMENT OF TRAINING OF SEMICONDUCTOR RELAY PROTECTION

DEVICES BY NEW INTERACTIVE METHODS. CURRENT RESEARCH JOURNAL OF PEDAGOGICS, 3(10), 28–33. https://doi.org/10.37547/pedagogics-crjp-03-10-05

19. 19.Абдуллаева , М. (2023). МИКРОПРОЦЕССОРЛИ РЕЛЕЛАРНИ ЎҚИТИШДА ИННОВАЦИОН ЁНДОШУВЛАРДАН УНУМЛИ ФОЙДАЛАНИШ. *Engineering Problems and Innovations*. https://fer-teach.uz/index.php/epai/article/view/111