AJEMA GLOBAL RESEARCH NETWORK

AMERICAN Journal of Engineering, Mechanics and Architecture
Volume 3, Issue 2, 2025 ISSN (E): 2993-2637

Computer Models of Electrical Impacts on Adjacent Lines of Traction Systems

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Abstract: The article develops computer models of electrical impacts on the adjacent lines of the traction system 20 kilometers from the Chinaz station of the Tashkent-Syrdarya road. Studies have shown that the greatest value of the induced voltage occurs in the middle of the line when the beginning and end of the adjacent line are grounded, but its value does not exceed 8 V. It was also determined that to reduce the value of the induced voltages from the electrical impact of the thrust system, it is sufficient to ground the investigated side line from both sides, and if the value of the induced voltage in this case is higher than 25 volts, the line should be grounded in several places, including in the middle of it.

Keywords: traction system, electrical effect, modeling, signaling, centralization, blocking, adjacent line, induced voltage.

Introduction.

The traction system and various types of transformers, power lines, have an electromagnetic connection and consist of static multi-wire elements consisting of several wires or windings. If these wires (winding) are combined within the investigated limit of the traction system, then the lines and transformers differ from each other in their mutually inductive nature between the wires or winding. To fully analyze the effects of the traction system on adjacent lines, taking into account these processes, we will develop computer models of linear electrical effects acting in different modes using the Matlab program.

To assess the impact of the traction system on the signaling, centralization, and blocking (SCB) wire, a computer model was developed using the SimPowerSystems and Simulink packages of the Matlab program, allowing for the determination of the voltage arising in the SCB line from the electrical impact of the traction system on the unladen mode of the SCB wire (Fig. 1). Using this model, an oscillogram of the induced voltage arising in the SCB wire was obtained when the voltage in the contact wire was 27.5 kV (Fig. 2).

Materials.

Based on the results obtained using a computer model, a voltage with an amplitude of 1130 V and an operating value of 800 V arises in the unallocated SCB wire. Such a value of the induced

voltage is considered very dangerous and even requires protective measures (one-or two-sided grounding of the off SCB line) when servicing the off SCB line.

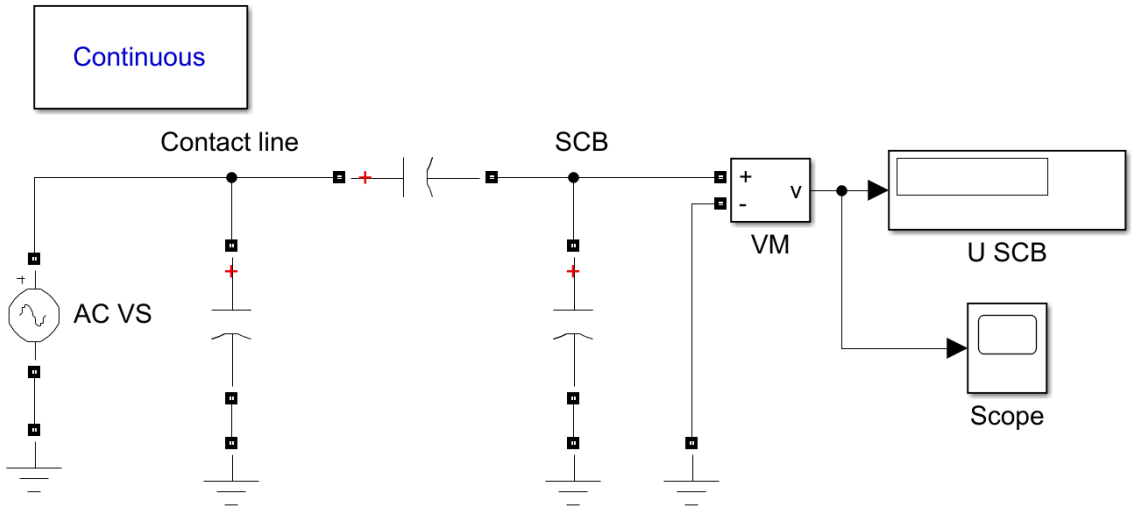

Figure 1. A model for determining the voltage arising in a traction system's traction line under electrical action.

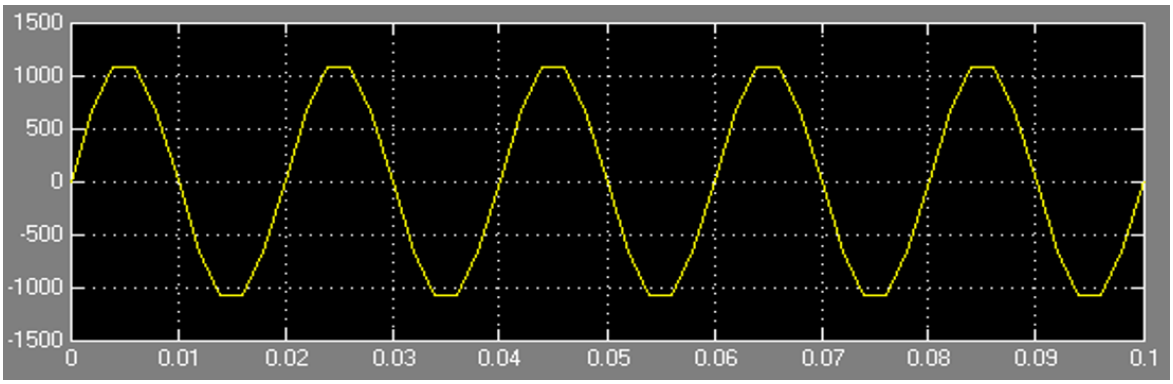

Figure 2. Oscillogram of the voltage arising in the SCB line from the electrical action of the traction system.

Let's consider how the grounding of the terminated line, 20 kilometers from the Chinaz junction of the Tashkent-Syrdarya highway, affects the magnitude and distribution patterns of the induced voltage generated along the line (Fig. 3). To do this, we will develop a computer model of the investigated area using the corresponding points of the Matlab program. In this model, the induced voltage in the SCB line is simulated as an alternating current source, and the contact suspension is divided into 3 sections with dispersed RL parameters (length of 1 section is 6.67 km).

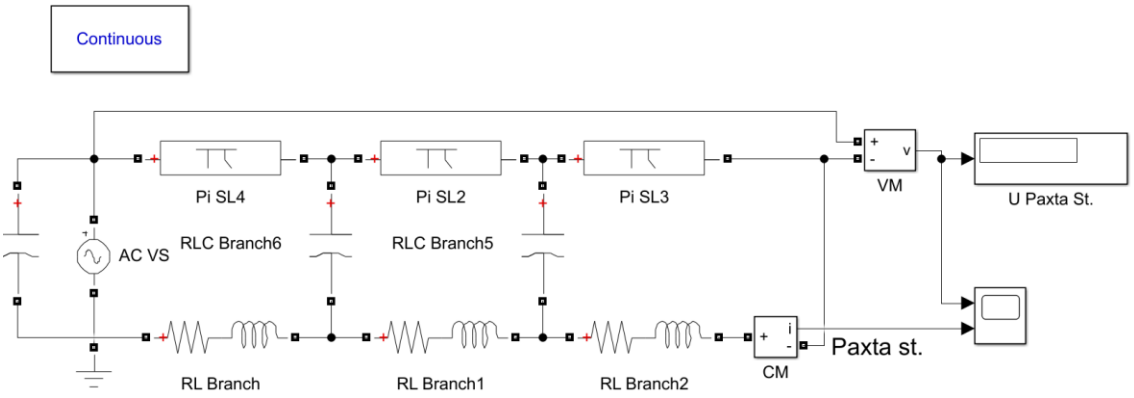

Figure 3. A model for determining the distribution of induced voltage across a line (line head is grounded)

Research and methods.

Voltage Measurement in the model indicates the value of the induced voltage at the end of the line, while Current Measurement indicates the value of the current in the grounding. From the voltage oscillogram obtained based on the model results, it is known that the voltage amplitude at the beginning of the grounded SCB line is approximately 8 V, while the current amplitude in the grounder installed at the end of the SCB line is 0.76 A (Fig. 4). Research has confirmed that the values obtained based on the results of the developed model differ from the results of theoretical calculations by up to 2% and that the reliability of the model and the effectiveness of ensuring the safety of its maintenance personnel as a result of the grounding of the power line can be increased.

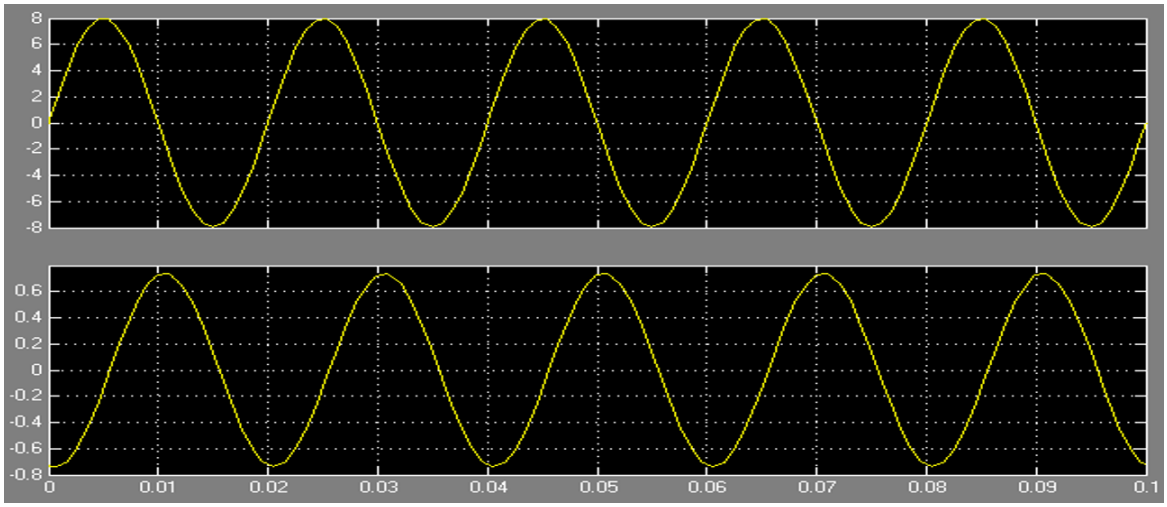

Figure 4. Oscillogram of the current in the grounder installed at the end of the line and the induced voltage at the beginning of the line (line beginning grounded)

If the "-" section of the Voltage Measurement is alternately connected to the ends of the Pi sections and the Current Measurement is alternately connected to the RL networks simulating ground resistance, then we obtain a graph of the distribution of the induced voltage and current along the line (Fig. 5). Using these curves, it is possible to determine the magnitude of the induced voltage and current in any part of the investigated sections.

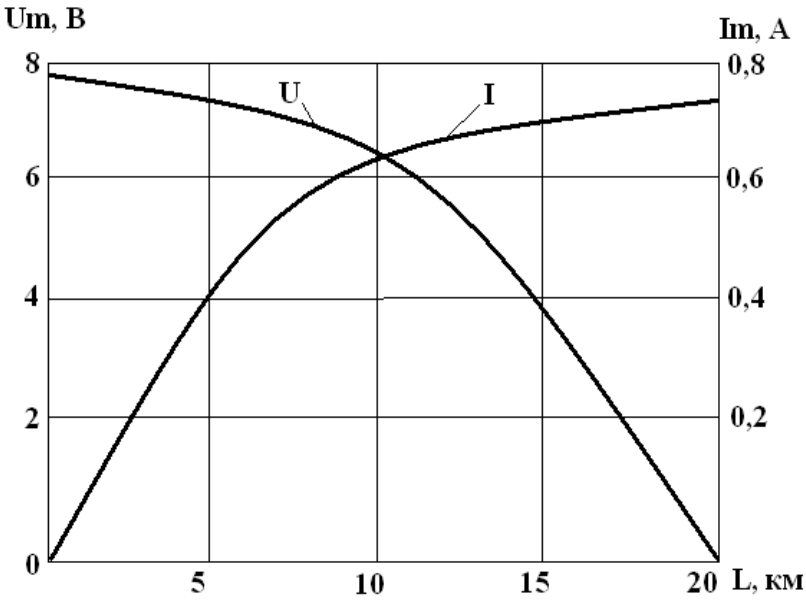

Figure 5. Curves of change of induced voltages at the beginning of the line and current in the grounder installed at the end of the line

Now let's consider the distribution of the induced voltage that can occur in the adjacent line when the adjacent line is ground on both sides for the same section. For this case, we will develop a computer model using the Matlab program (Fig. 6).

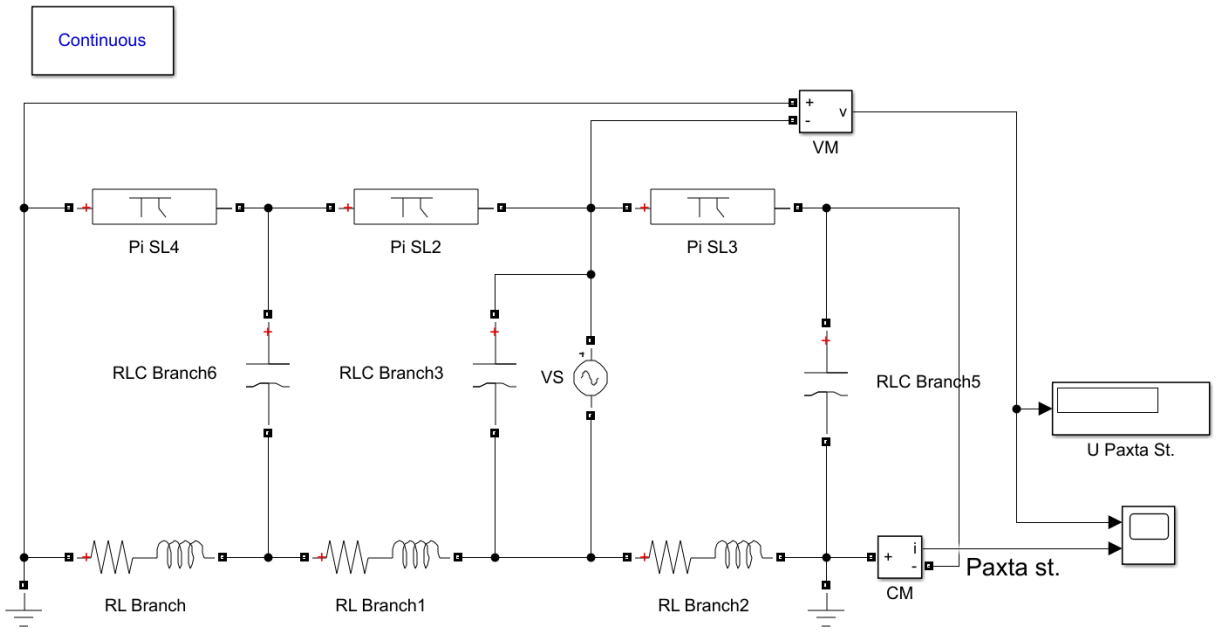

Figure 6. A model for determining the distribution of induced voltage across a line (the beginning and end of the line are grounded)

Results.

Using the Scope element in the developed computer model, we obtain an oscillogram of the current value and the induced voltage in the grounders (Fig. 7).

Based on the results of the computer model, we can see that the value of the induced voltage remains unchanged due to the ground state of the switched-off line head, while the value of the current in the grounders decreases by half due to the flow of two grounders.

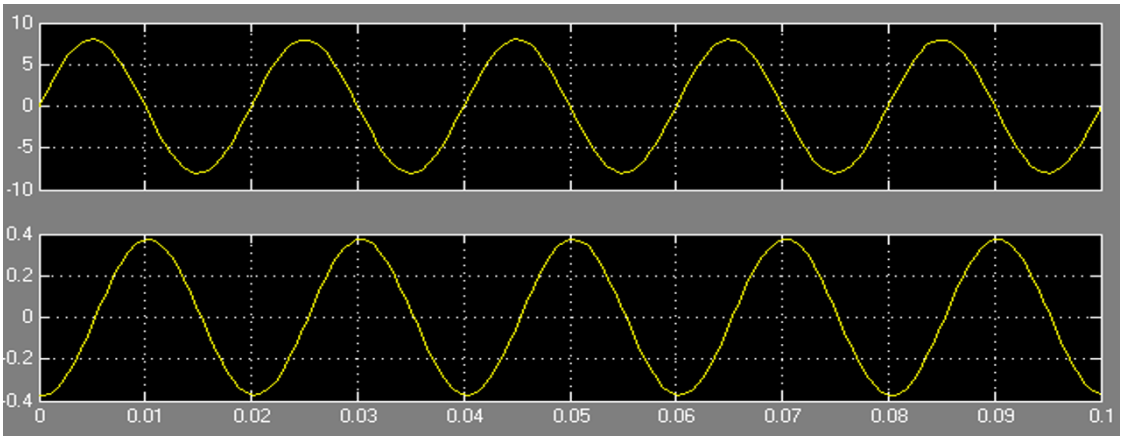

Figure 7. Oscillogram of current and line-induced voltage in the grounders installed on the line (the beginning and end of the line are grounded)

Discussion.

Using the computer model shown in Figure 6, to determine the magnitude of the induced voltages and currents flowing through the grounders at any point in the line, we construct curves of the dependence of the induced voltages and currents in the grounders on the distance (Fig. 8).

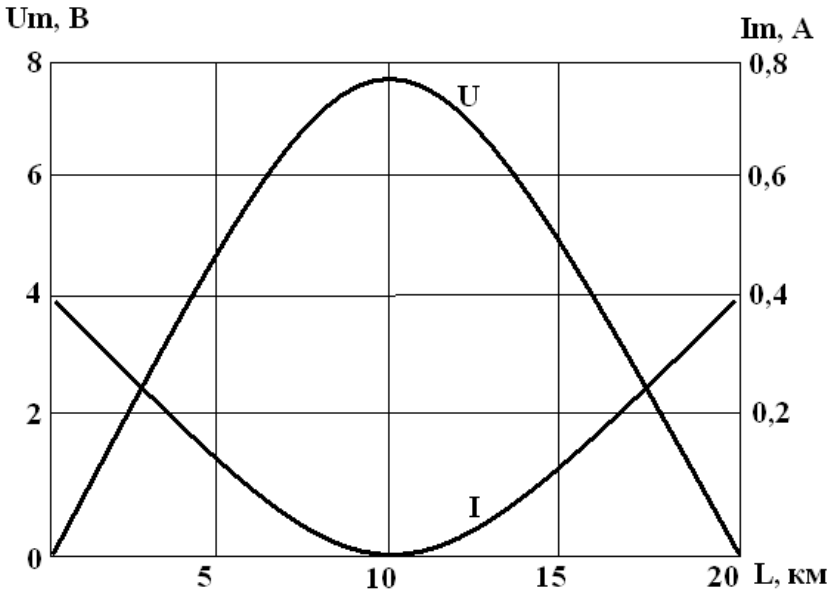

Figure 8. Curves of current and line-induced voltage changes in the grounders installed on the line.

Conclusion.

Studies have shown that the greatest value of the induced voltage corresponds to the middle of the line, but its value does not exceed 8 V. From this, it can be concluded that to reduce the magnitude of voltages induced by the electrical action of the thrust system, it is sufficient to ground the investigated side line on both sides. If the induced voltage value remains above 25 volts after grounding, it is necessary to ground the line in several places, including its middle.

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