Power Systems Lab

Experiment 8

Laboratory Report

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1 Objective

Develop a simulink model for the single phase energization of a 3-phase transmission line.

Let the given problem be as follows:

A 250 km, three-phase line is energized on a 100 kV network. The line is first energized on phase A at t = 1/4 cycle (maximum of source voltage). Phase B and phase C are left open. Find the transients on the moment of switching.

2 Theoretical Background

2.1 Long Transmission Line

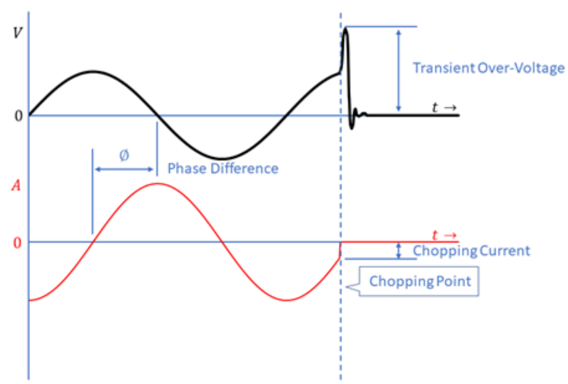
A long transmission line is defined formally as a power transmission line with an effective **length more than 120 km**. Unlike short transmission lines and medium transmission lines, it is no longer reasonable to assume that the line parameters are lumped.

In a long transmission line the line constants are uniformly distributed over the entire length of line. This is because the effective circuit length is much higher than what it was for the former models (long and medium line) and hence we can no longer ignore the shunt admittance of the line and ignore the mutual inductance of the line.

2.2 Switching Transients in Circuit Breakers

Switching transients occur in power systems each time an abrupt circuit change occurs. These transients are short lived and oscillatory in nature.

In a typical switching operation, such as a contactor or breaker opening or closing, switching transients occur on an electrical load each time an abrupt circuit change, or current chop, occurs. When the two breaker contacts separate, an arc is created in the interrupter that maintains current flow.



3 Implementation

The model is implementated by using the **distributed parameters line and the long line Pi-model** in the Simscape Electrical library of Simulink. A **single-phase voltage source** is connected via a source impedance to a circuit breaker.

The line is energized by the closing of this circuit breaker. As breaker closes at 1/4th of the cycle, it produces a **transient current**. When the breaker contacts join, an arc is created in the interrupter that maintains current flow. As the current approaches its next zero-crossing, the arc weakens then extinguishes.

Switchings are performed simultaneously on two different line models:

A . Distributed Parameters Line

B . Pi-model Parameters Line

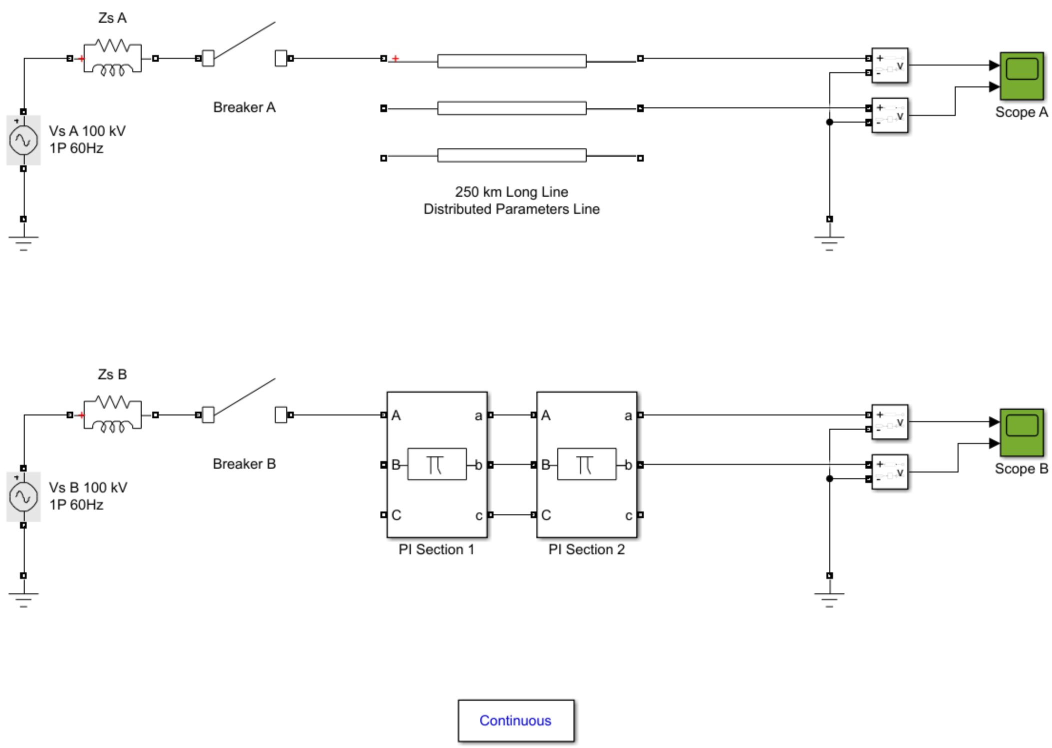


Figure 1: Simulink Model Implementation

For both of these models, **we measure the voltage on the recieving end** between the phase A to Ground, as well as phase B to Ground.

4 Observations

For both of the transmission line models, we measured the voltage on the recieving end between the phase A to Ground, as well as phase B to Ground.

4.1 Distributed Parameters Line

At the moment of switching the **phase voltage increases to 137.3 kV peak** and oscillates at the system frequency. **This lasts for 400 ms,** and the **voltage settles at 103.2 kV.**

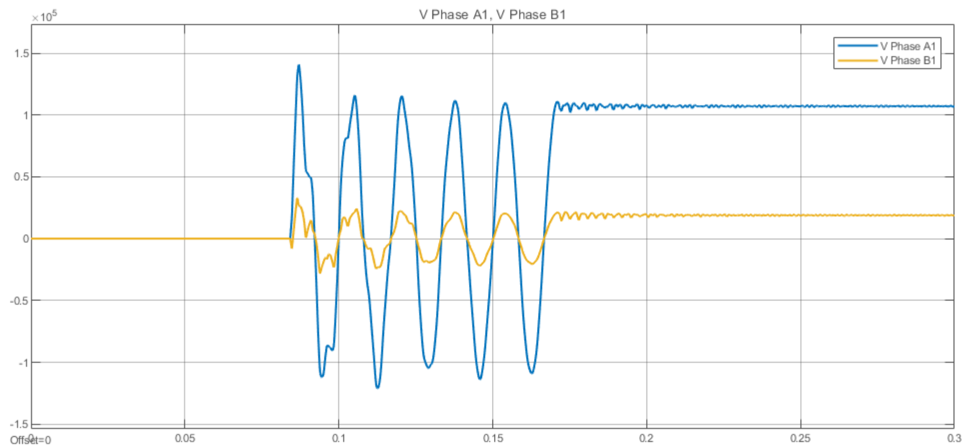


Figure 2: Distributed Parameters Line

4.2 Pi-model Parameters Line

At the moment of switching the **phase voltage increases to 139.7 kV peak** and oscillates at the system frequency. **This lasts for 430 ms,** and the **voltage settles at 110.5 kV.**

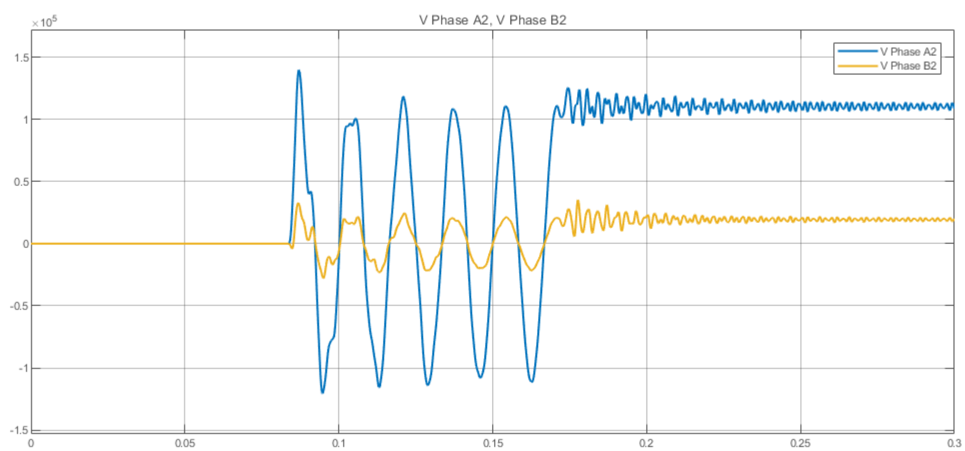


Figure 3: Pi-model Parameters Line

We also observe that in both cases, there is a voltage induced in phase B which follows the oscillation of phase A and **rises to a peak of 32.4 kV.**

5 Result

We observed the single phase energization transients in a 3-phase transmission line with two line models. We also observed that in both cases, there is a voltage induced in the adjacent phase which follows the oscillation of the energized phase.