Kersting’s “4-Wire Delta” Example



Figure 1. One-line Circuit Model



Figure 2. OpenDSS Detailed Model

This example illustrates some of the modeling issues with difficult transformer connections, particularly if serving DG. We’ll start with Kersting’s IEEE test case that uses an induction motor. Then we’ll switch it to an induction generator. Finally, we’ll remove one of the 1-phase transformers to make it an Open-Wye/Open-Delta bank.

From the 4-wire Delta folder, open *Kersting4wireIndMotor.dss* and execute the script through the Solve command. How many iterations did it take to solve this case?

In the block comment at the bottom execute the command to show the voltages. How do you explain the pu voltages at LOADBUS?

In this model, the induction machine is modeled with the INDMACH012a.DLL under the Generator model. It is defined with “Option=FixedSlip” change this to “Option=Variableslip” and execute the script again. How many iterations did it take this time? Do the Show Power command. Note that the slip was adjusted to match the power specified by the kW property (21.6). What is the slip? (Do Show Variables to show the state variables from the induction machine model.)

Now, let’s assume that instead of an induction motor, the customer has install an induction machine wind turbine generator. Change the sign on the kW property and solve again. (Positive kW means the Generator is producing power) How many iterations? What is the power in the machine? What is the slip?

Now, let’s assume the customer is served from an open-wye/open-delta bank and we need to assess whether it can serve the wind generator. Adjust the circuit model as follows:

1. Remove transformer CA by putting a block comment around its definition
2. Connect the neutrals of the primaries of the two remaining transformers to ground

Solve. Do show variables. What is the slip? Losses in the motor?

What do you think about the loading on the two remaining transformers?

ELEMENT = "Transformer.XFMRAB"

kW kvar kVA PF

PRIMARY 1 -0.1 +j 10.1 10.1 -0.0128

PRIMARY 0 0.0 +j 0.0 0.0 1.0000

TERMINAL TOTAL . -0.1 +j 10.1 10.1 -0.0128

SECONDARY 1 0.8 +j -4.2 4.2 -0.1920

SECONDARY 0 0.0 +j 0.0 0.0 1.0000

TERMINAL TOTAL . 0.8 +j -4.2 4.2 -0.1920

SECONDARY 0 0.0 +j 0.0 0.0 1.0000

SECONDARY 2 -0.6 +j -5.9 5.9 0.1079

TERMINAL TOTAL . -0.6 +j -5.9 5.9 0.1079

ELEMENT = "Transformer.XFMRBC"

PRIMARY 2 -4.8 +j 13.7 14.5 -0.3324

PRIMARY 0 0.0 +j 0.0 0.0 1.0000

TERMINAL TOTAL . -4.8 +j 13.7 14.5 -0.3324

SECONDARY 2 -4.7 +j -5.5 7.2 0.6467

SECONDARY 3 9.8 +j -7.9 12.6 -0.7792

TERMINAL TOTAL . 5.2 +j -13.4 14.4 -0.3596