ELEC0029 - Electric power systems analysis

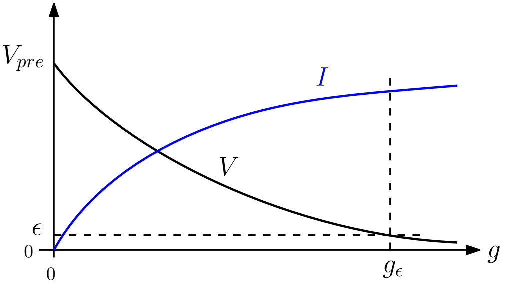
Case study: analysis of unbalanced faults in a small distribution network
Additional material

Thierry Van Cutsem
t.vancutsem@ulg.ac.be www.montefiore.ulg.ac.be/~vct

March 2020

Slide 3 (footnote)

Simulation of a fault with a shunt conductance g applied to the faulted bus and phase.



V_{pre} is the pre-fault voltage, i.e. the voltage without the fault ($g = 0$).

ϵ is a small tolerance, below which the voltage V is considered negligible, i.e. close enough to zero.

The fault calculations can be done with the conductance g_ϵ.

Slides 7 and 8

Phase angle of voltage at bus B :

- by the power flow computation : $-1,9$ deg
- by this computation : $-31,9$ deg

Phase shift due to transformer A-B $=$ 30 deg

Slide 9

Phase angle of voltage : $-31,9$ deg   Phase angle of current : -62 deg

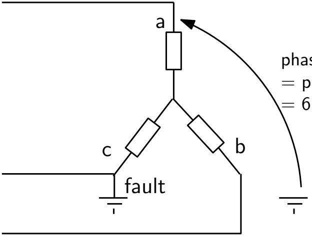
Three-phase powers entering the cable :

$$\begin{aligned} P &= 3 \times 21,39\ 10^3 \times 165,4 \times \cos(-31,9 - (-62)) = 9,18 \text{ MW. OK} \\ Q &= 3 \times 21,39\ 10^3 \times 165,4 \times \sin(-31,9 - (-62)) = 5,32 \text{ Mvar. OK} \end{aligned}$$

The slide shows the magnitude of the algebraic sum of currents $= |\bar{I}_a + \bar{I}_b + \bar{I}_c|$

$$|\bar{I}_a + \bar{I}_b + \bar{I}_c| \neq |\bar{I}_a| + |\bar{I}_b| + |\bar{I}_c| \quad !!!!!$$

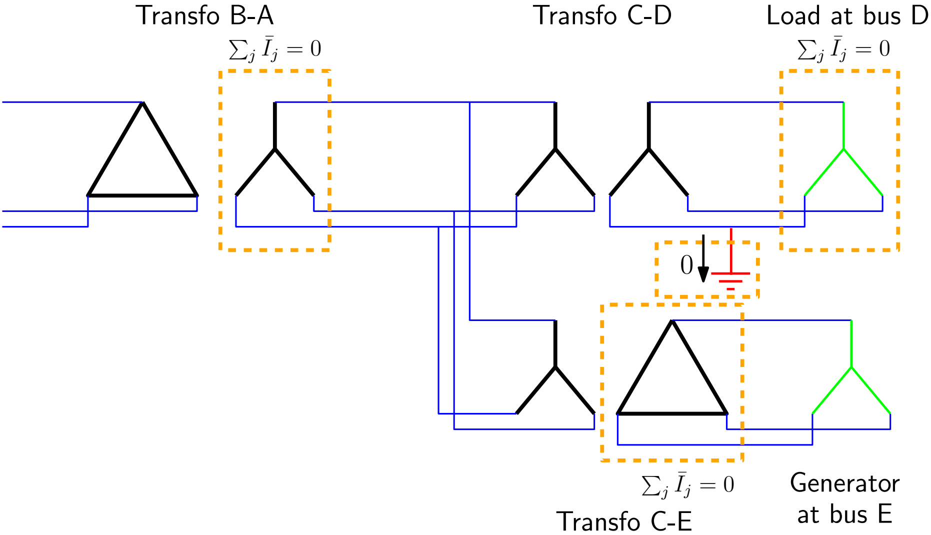
Slides 12 and 13



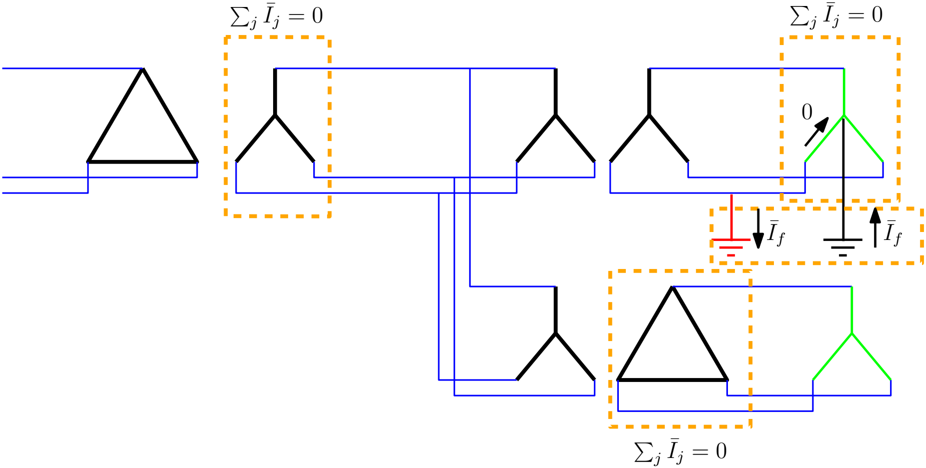
In the absence of grounding of the neutral, due to the fault, the phase-to-ground voltages of the (non faulted) phases a and b at bus D become equal to the phase-to-phase voltages before the fault.

- the voltage between neutral and ground changes from 0 to $6/\sqrt{3}$ kV
- voltages elsewhere in the network are not at all affected
- the fault is impossible to detect !
- the absence of grounding is dangerous !

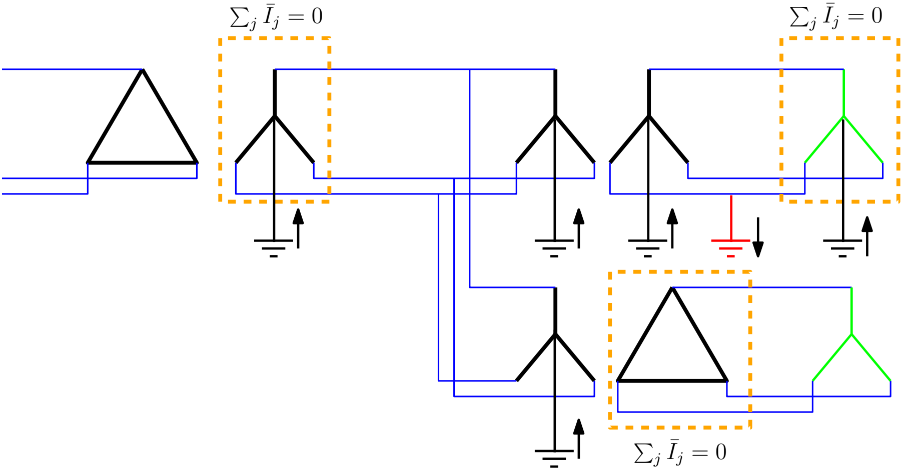
Slides 12 and 13



Slides 14 and 15



Slides 16 and 17



Slide 18