Fast Bus Changeover

Theoretical concepts

As per ANSI C50.41 standard, a fast transfer or reclosing is defined as following:

- The maximum phase angle (δ) between the motor residual volts per hertz vector and the system equivalent volts per hertz vector does not exceed 90 degrees.
- The resultant volts per hertz (V/Hz) between the motor residual (V/Hz) phasor and the incoming source (V/Hz) phasor at the instant of transfer or reclosing does not exceed 1.33 per unit on the motor rated voltage and frequency basis.
- Occurs within a time period of 10 cycles or less.

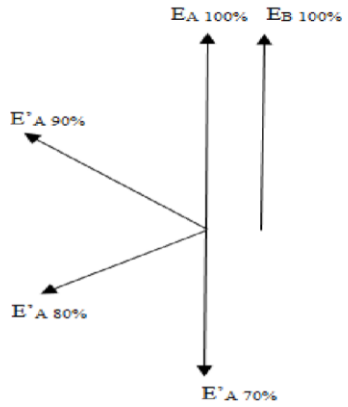
The dynamic transfer from tripped bus to healthy bus is done without resulting in

- Severe voltage dip on the healthy bus, with allowable dip of 10 to 15%.
- Long term overloading of healthy bus.

During the dynamic transfer, motors are not tripped & are allowed to reaccelerate. After the incomer breaker trips, the voltage of the tripped bus decays slowly due to the back emf of the motors & rate of decay depends on the inertia and trapped flux in the motors. After the incomer breaker trips, voltage & frequency (or phase angle) of the faulted bus decays. The speed drop in motors are represented as phase angle shift of motors.

Consider E_B & E_A as the healthy bus and tripped bus voltages respectively. The back emf of tripped bus decays in voltage with time and also shifts in phase w.r.t E_B. At some instant, E_A & E'_A are in opposition and 1.7 times the voltage gets applied across the trip bus as shown below. This results in

- High current during reacceleration when motors are transferred to healthy bus.
- High torque that is damaging to motor shaft.



Generally, motor designers have established following rule based on conservative margins. Reclosing or transfer of induction motors should be avoided, when the phasor difference between residual voltage of tripped bus & the incoming system voltage exceeds 125% - 135% of the rated voltage of the motor.

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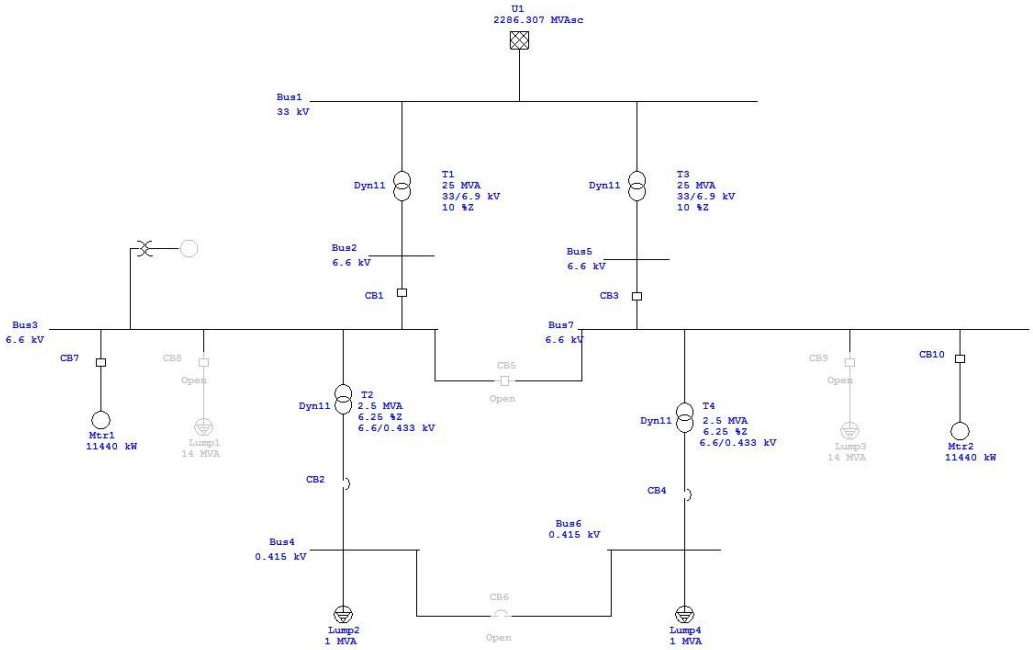
Purpose and Description

The purpose of this exercise is to transfer dynamic load from tripped bus to healthy bus. ANSI C50.41 standard will be followed during this example.

Procedure

1. Consider the faulted motor transient system model as shown below.



2. To study fast bus transfer, change the existing network configuration as shown below.

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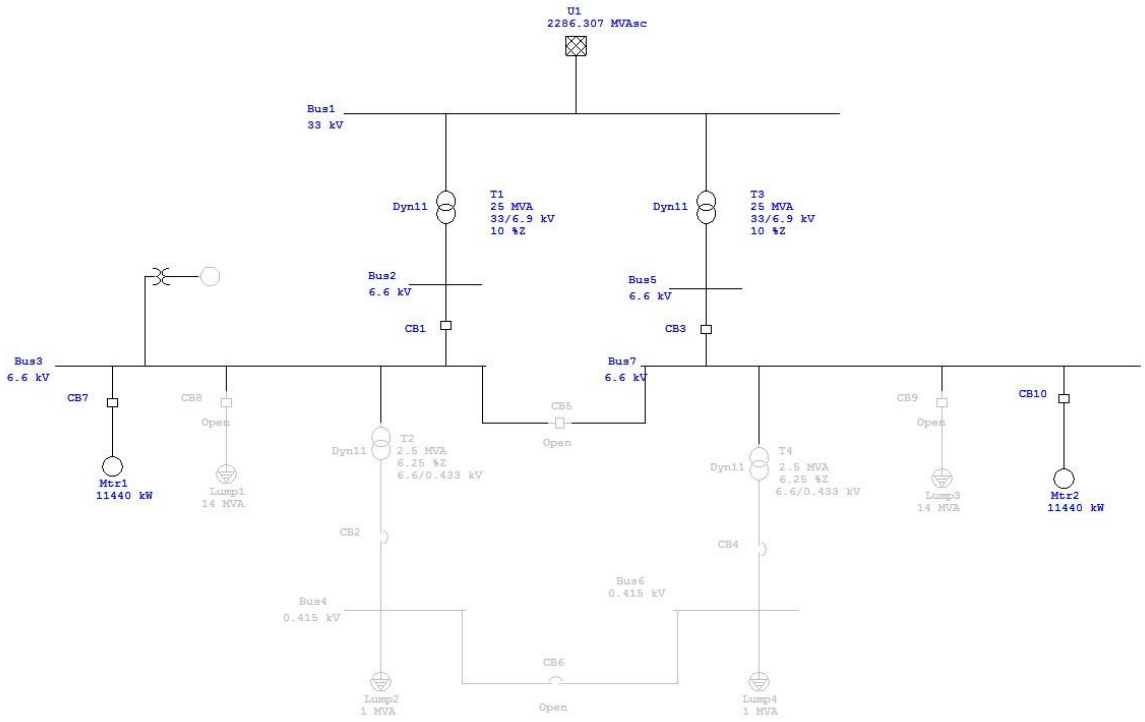

3. Go to Transient Stability Analysis module and create new case study case with name "FCOS"
4. Go to events page and create an event to open CB1 at 1 sec as shown below.

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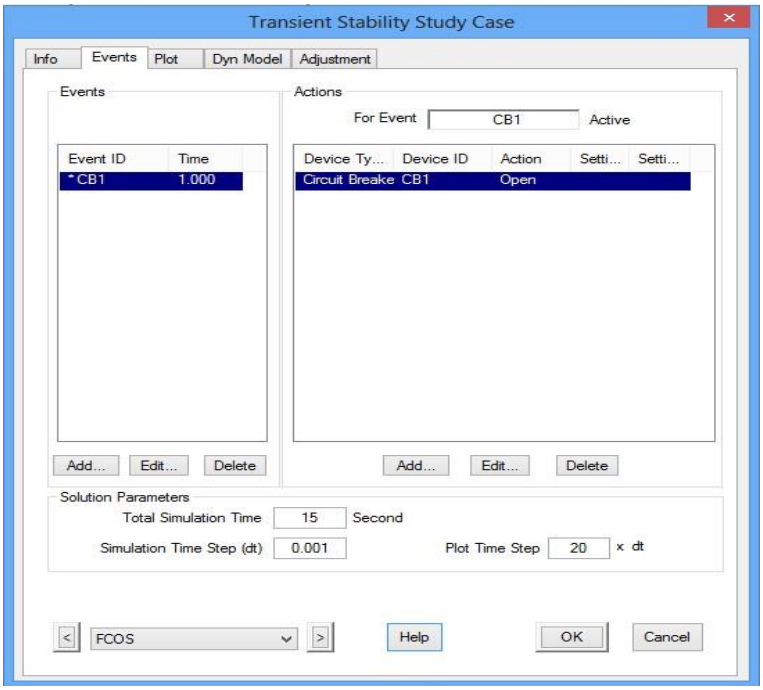
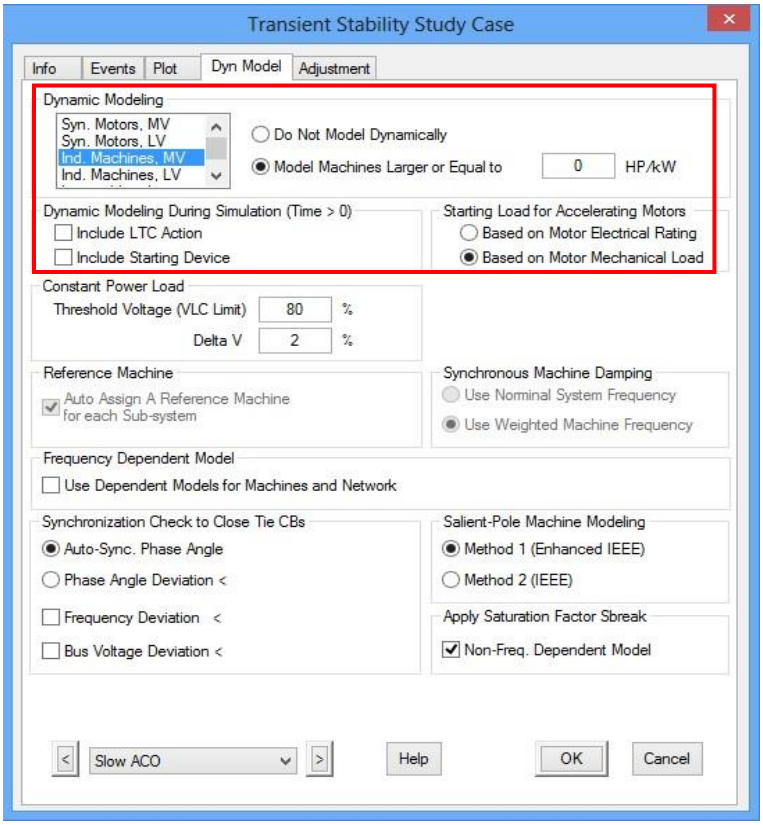


5. Set the options on the Dyn Model page of transient stability study case as shown.



6. Go to Plot page, click on Buses in device type and select buses of interest in plot options as shown below.

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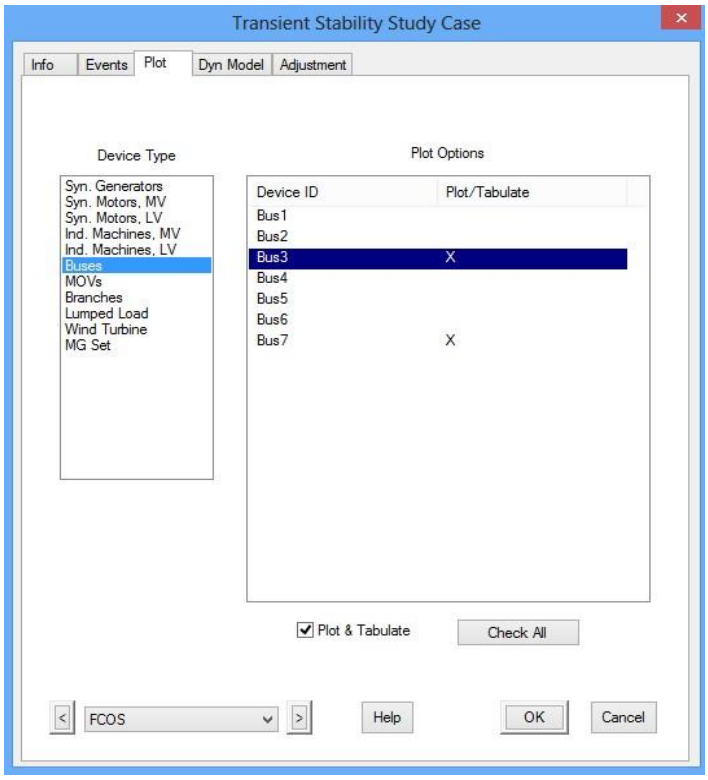
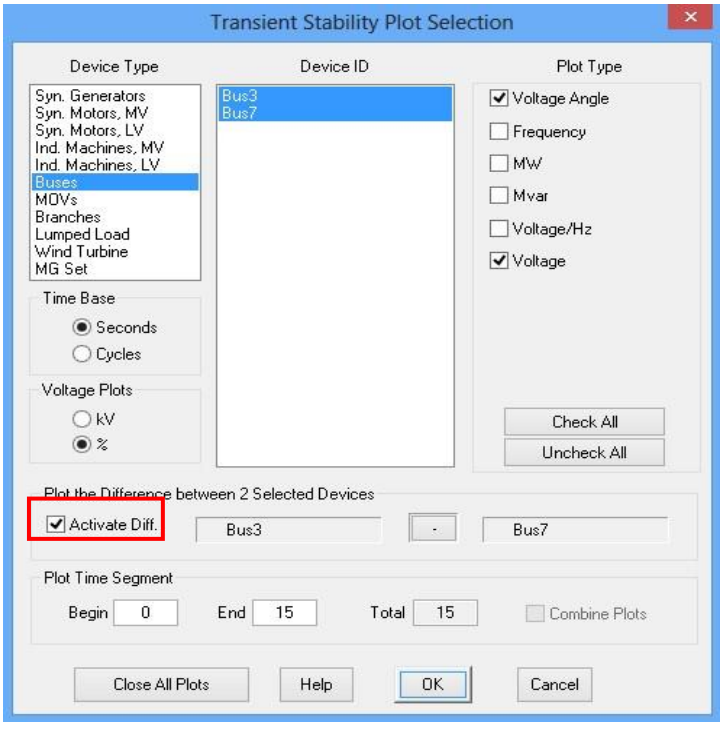


7. Run Transient Stability and click on transient stability plot, check the Activate Diff. check box to view difference in Bus3 & Bus7 Voltage & Voltage Angle as shown below.



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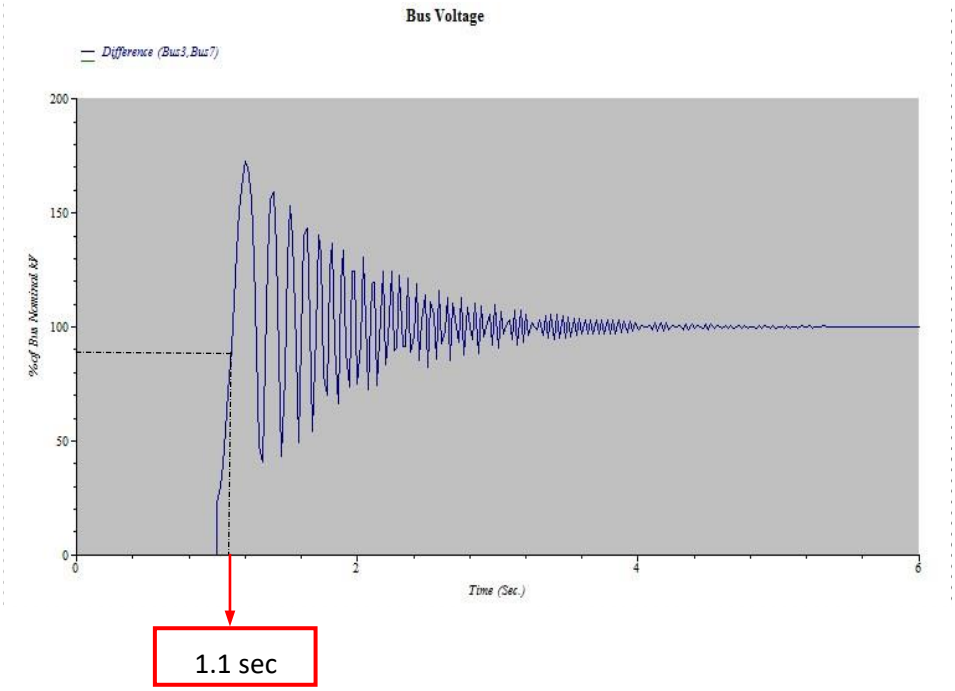
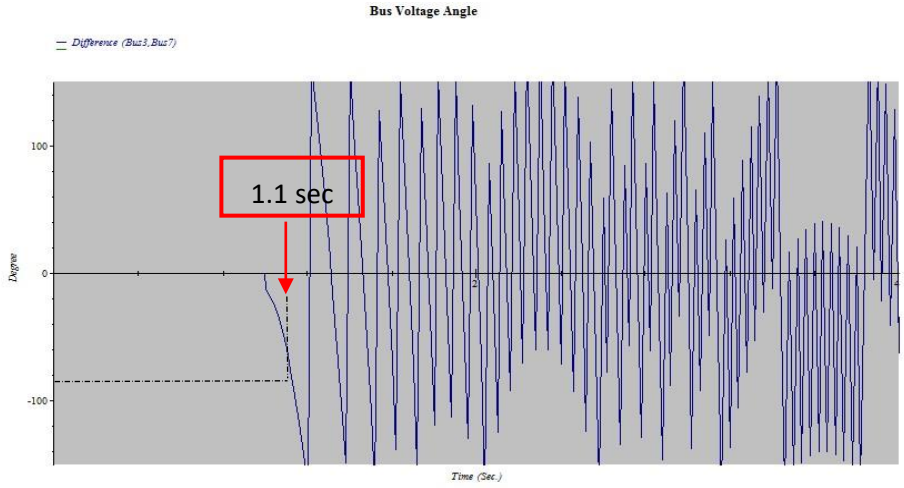
Bus Voltage



Bus Voltage Angle



Check for the below mentioned conditions for the above graphs and note the time for which CB5 is to be closed.

- The maximum phase angle (δ) between the motor residual volts per hertz vector and the system equivalent volts per hertz vector does not exceed 90 degrees.
- The resultant volts per hertz (V/Hz) between the motor residual (V/Hz) phasor and the incoming source (V/Hz) phasor at the instant of transfer or reclosing does not exceed 1.33 per unit volts per Hz on the motor rated voltage and frequency basis.

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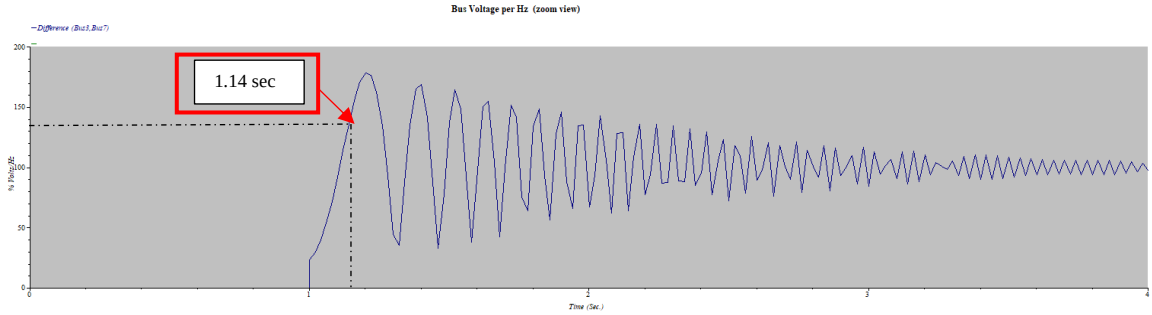
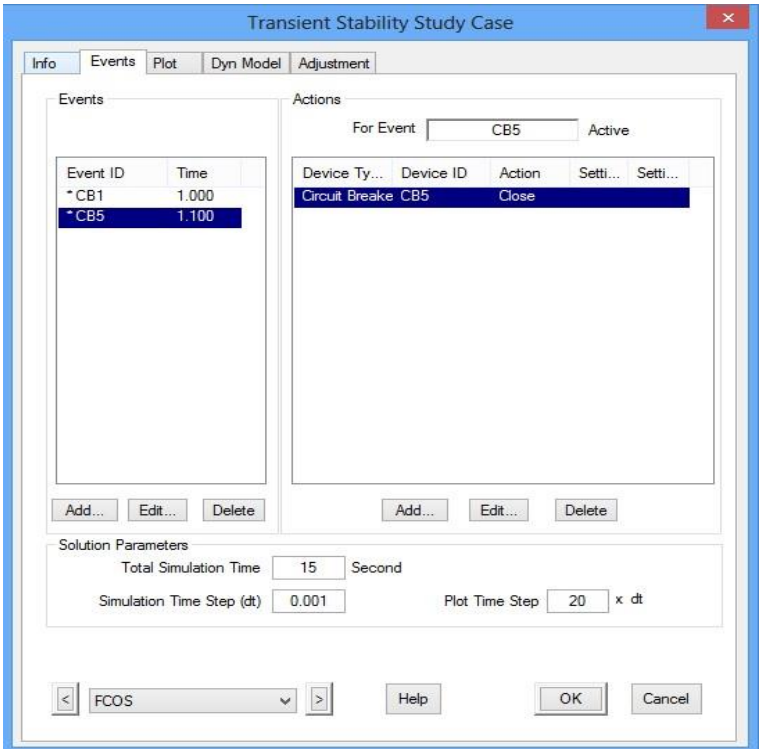


- Time for closing the bus-coupler should be selected such that over fluxing is below 1.33pu volts per Hz on motor rated voltage and frequency.

8. Go to Edit Study Case, click on Events page & add the event as shown below to close the CB5 at 1.1 sec.



9. Run Transient Stability and click on transient stability plot to view bus voltage/Hz & Induction motor slip at Bus3 & Bus7.

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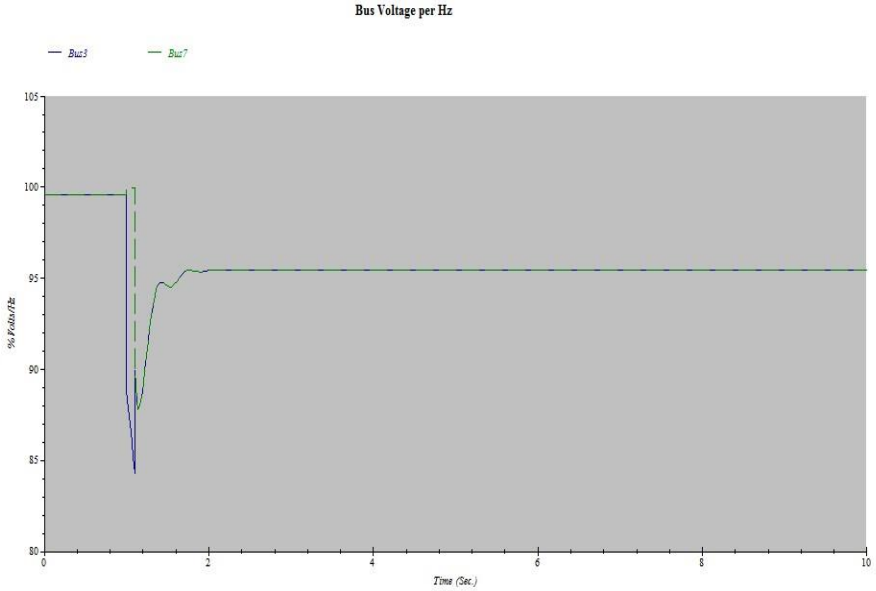
Bus Voltage per Hz



Motor Slip