On-Load Tap Changer for Transformer

Written for PSCAD v4.5 and better.

1   General Description

In power system studies it is normal to use Tap changer for voltage regulations such as:

- Regulate the load side voltage (or supply side voltage) of transformer due to variations in load power

- Regulate the load side voltage (or supply side voltage) of transformer due to supply voltage variations.

Tap changer can be off-load or on-load:

- Off-load Tap changer regulate voltage when the transformer is out of service and supplying the load

- On-load Tap changer regulate voltage when the transformer is in service and supplying the load

2   Tap Changer Model

The Tap changer model is shown in the Figure 1. Right click on the component and select edit parameters to see the parameters of the component as shown in Figure 1.
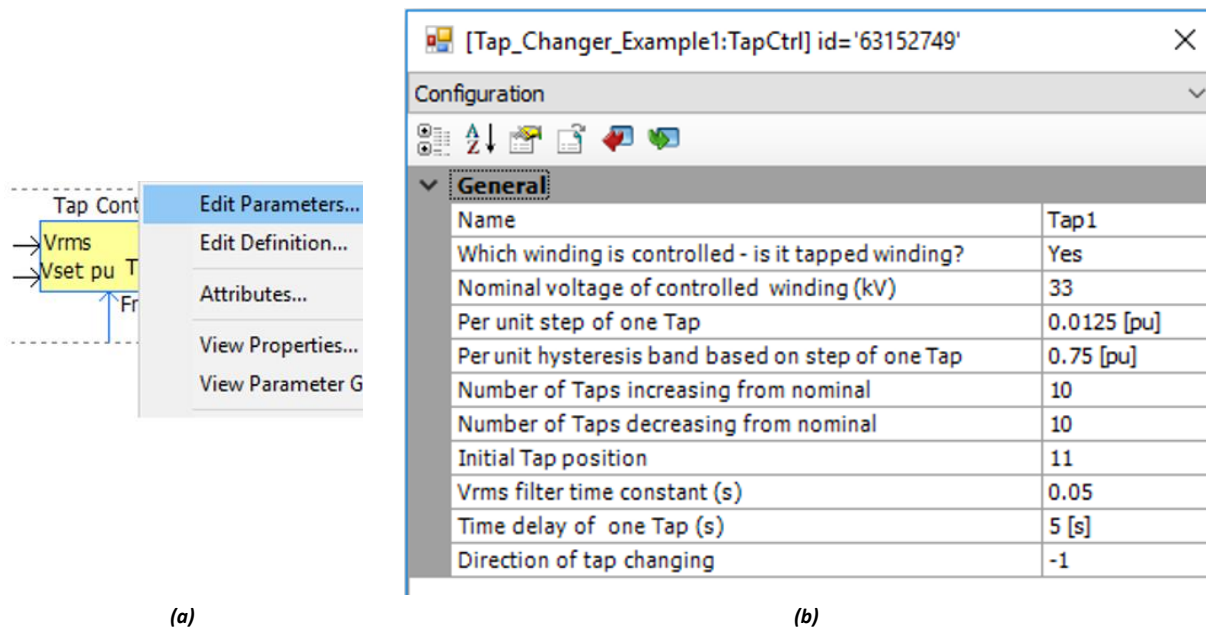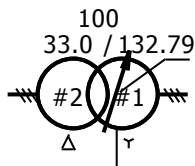

(a)   (b)

Figure 1: (a) Tap changer component (b) settings and parameters

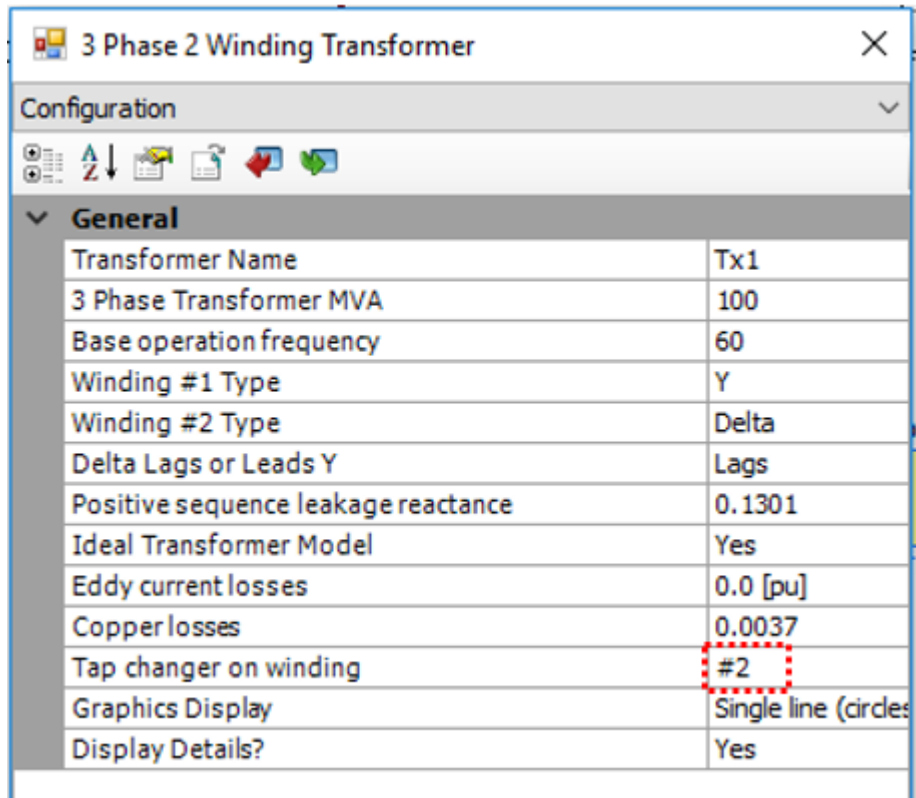Table 1 describes the parameters of the Tap changer component.

Table 1: Description of the parameters of the Tap changer model

Parameter	Description
Name	Select a name for the tap changer
Which winding is controlled - is it tapped winding?	Tap changer can control the voltage of the winding that has a tap on or the voltage of the winding that does not have tap on. In this example this option is chosen as "Yes". It means that the tap changer is controlling voltage of the winding # 2 (see Transformer parameters) where the tap changer is installed.
Nominal winding voltage of controlled voltage (kV)	Nominal voltage of the winding we select to control its voltage. In this example the winding # 2 is selected therefore nominal voltage of this winding (33kV) is entered.
Per unit step of one Tap	Each Tap can change the voltage by this value multiply the nominal voltage. In this example it is 0.0125pu therefore each tap changes the voltage by 0.0125×33 kV = 0.4125kV.
Per unit hysteresis band based on step of one Tap	The hysteresis band which is a percentage of the per unit step of one Tap. In this example it is 0.75 pu therefore the hysteresis band for voltage is 0.75 ×0.4125 = 0.309375 kV.
Number of Taps increasing from nominal	---
Number of Taps decreasing from nominal	---
Initial Tap position	The position of tap at the initially
Vrms filter time constant (s)	The time constant for calculating rms voltage
Time delay of one Tap (s)	Tap changes after a time delay
Direction of tap changing	Tap can change positively or negatively based on the value chosen (+1 or -1)

Figure 2 shows the parameters of transformer with the Tap changer on the winding #2.

(a)   (b)

Figure 2: (a) transformer component (b) parameters

3   Example 1

Load the simulation case (i.e. Tap_Changer_Example1.pscx) into PSCAD. This example shows the operation of Tap changer to regulate the load voltage to its nominal value. The load voltage decreases or increases when the load power increases or decreases.

Figure 3 shows the loads connected to the winding #2 of the transformer. The BRK 1 connects its load to the transformer for the entire time of simulation (i.e. 120s). And BRK 2 initially is open therefore initially the load is disconnected from the transformer. But the BRK 2 connects the load at 20s and disconnect the load at 70 s.
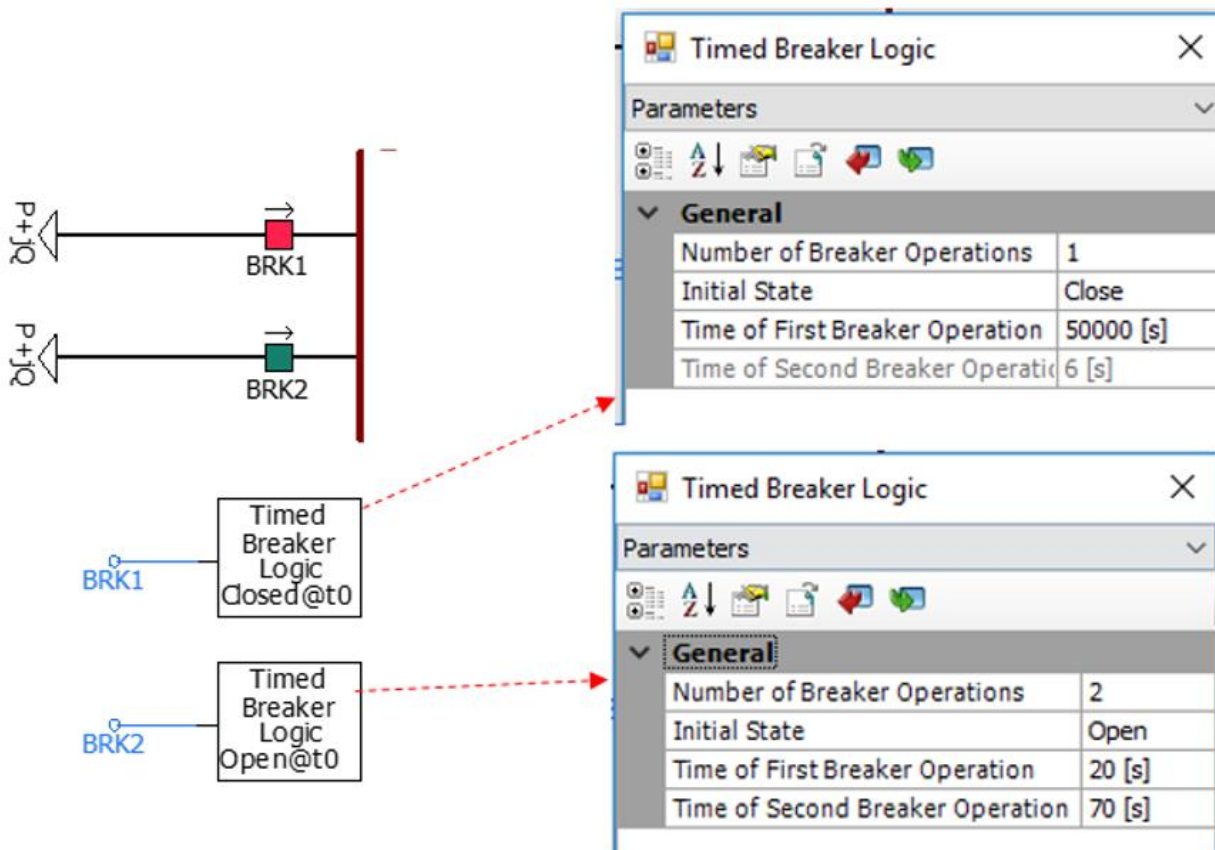

Figure 3: Loads and breaker; breaker (BRK1) connects the load to the transformer during simulation time, breaker (BRK2) is open firs but connects the load at 20s and disconects it at 70s

When the BRK 2 connects its load at 20s to the transformer, load power increases suddenly and causes voltage drop (V33) as shown in Figure 4. The Tap changer start to increase Tap after 5 s delay. After 7 Tap increases the voltage (V33) reaches at its nominal value at 55s.

When the BRK 2 disconnects its load at 70s from the transformer, load power decreases suddenly and causes voltage swell as shown in Figure 4. The Tap changer start to decrease Tap after 5 s delay. After 7 Tap decreases the voltage reaches at its nominal value at 105s.
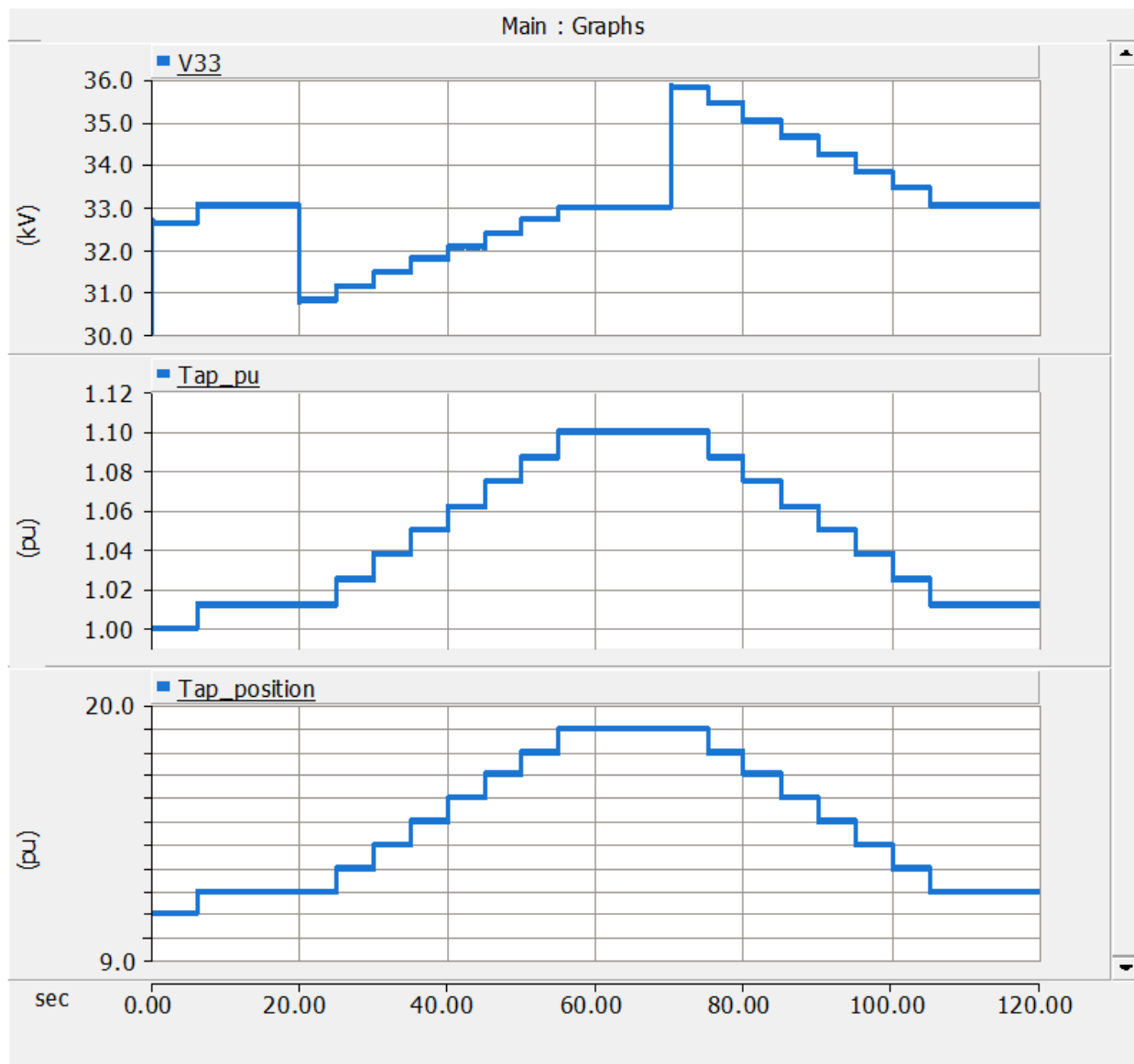
Figure 4: Simulation results

4   Example 2

Load the simulation case (i.e. Tap_Changer_Example2.pscx) into PSCAD. This example shows the operation of Tap changer to regulate the load voltage to its nominal value. The load voltage decreases or increases when the supply voltage decreases or increases. The load is constant and connected to the transformer during the entire simulation time.

Figure 5 shows the set up for the supply voltage. The supply voltage increases to 1.05 pu at 10 s and decreases to 0.95 pu at 60 s. This causes voltage variation on the load side and the Tap changer must react to maintain the load voltage.
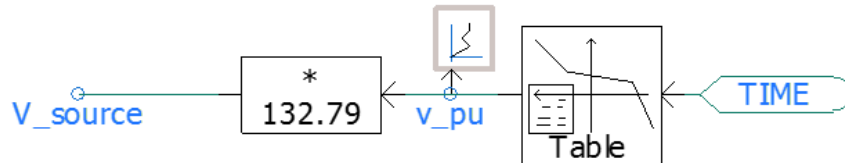

Figure 5: Supply voltage variation based on the simulation time

When supply voltage increases to 1.05 pu at 10s the Tap changer starts to reduce the Tap until the load voltage (V33) regulated to its nominal at 30s as shown in Figure 6.

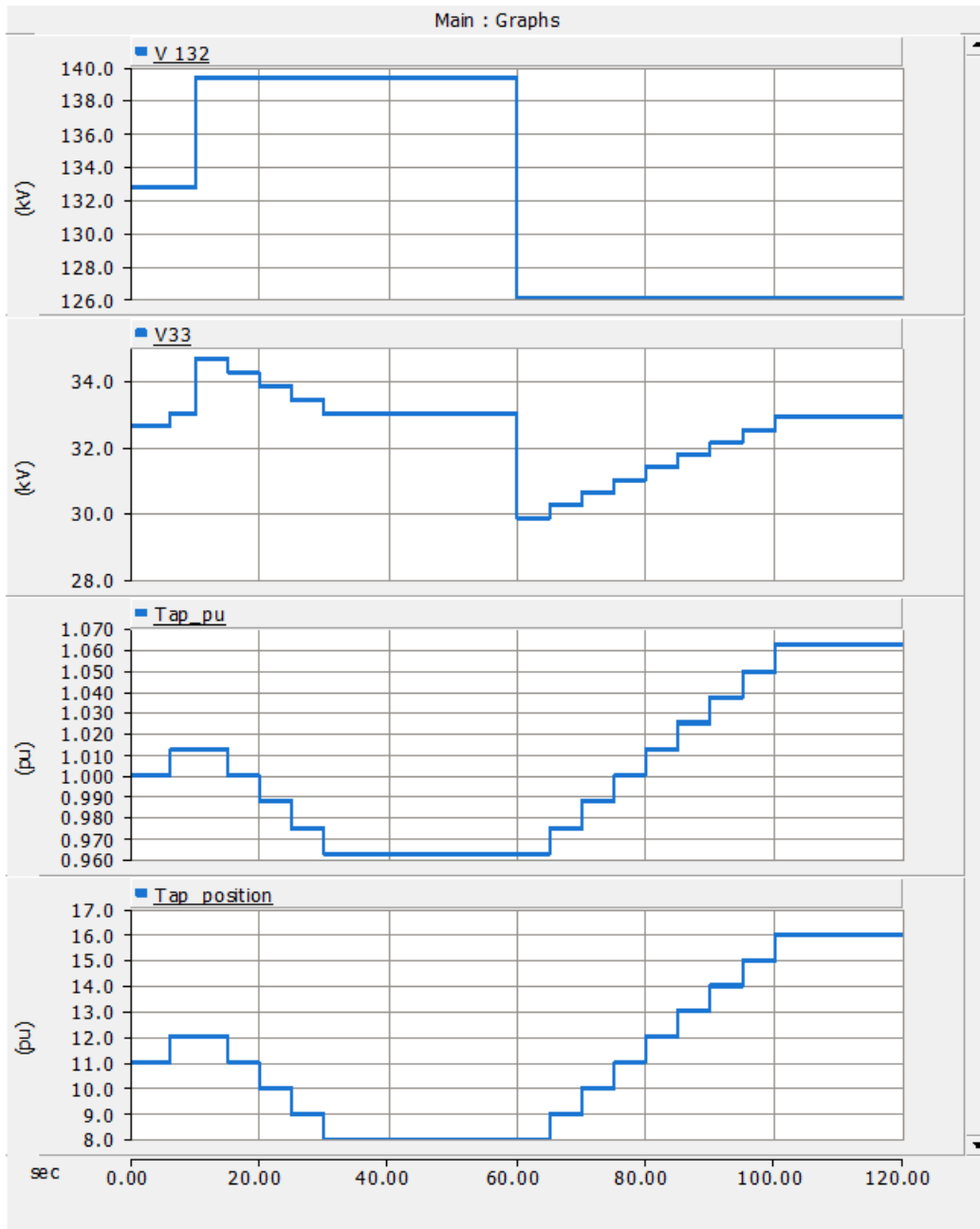When the supply voltage reduces to 0.95pu at 60s the Tap changer increases the Taps until the load voltage (V33) reaches to its nominal value at 100s.

Figure 6: Simulation results