RL Circuit Analysis Applied to Transformers with Tap Changers

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- RL circuit theory
- Response of an RL circuit to a voltage transient
- Adding/removing an RL branch from the circuit
- Adding a resistor to circuit
- Applications on OLTCs

RL Circuit Theory

- Response of an RL circuit to a voltage transient

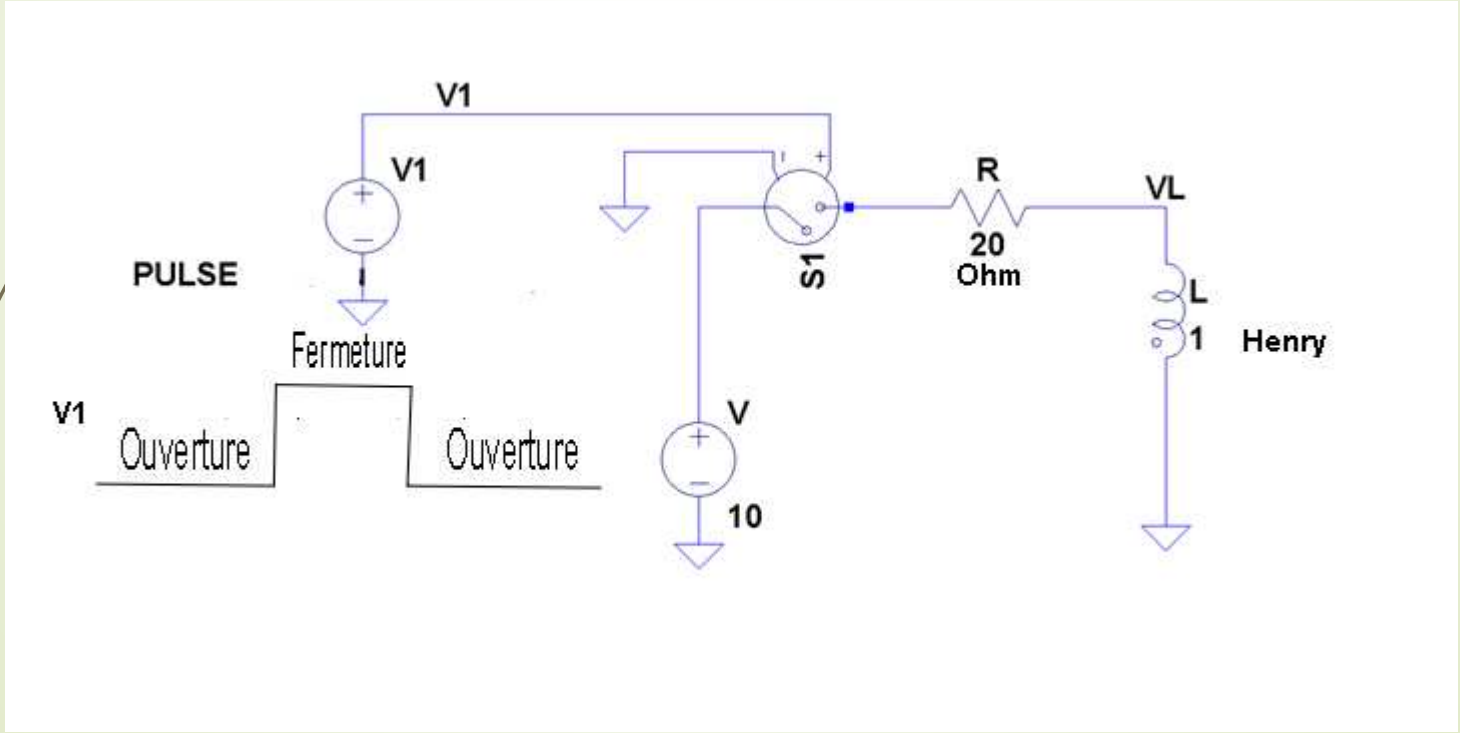


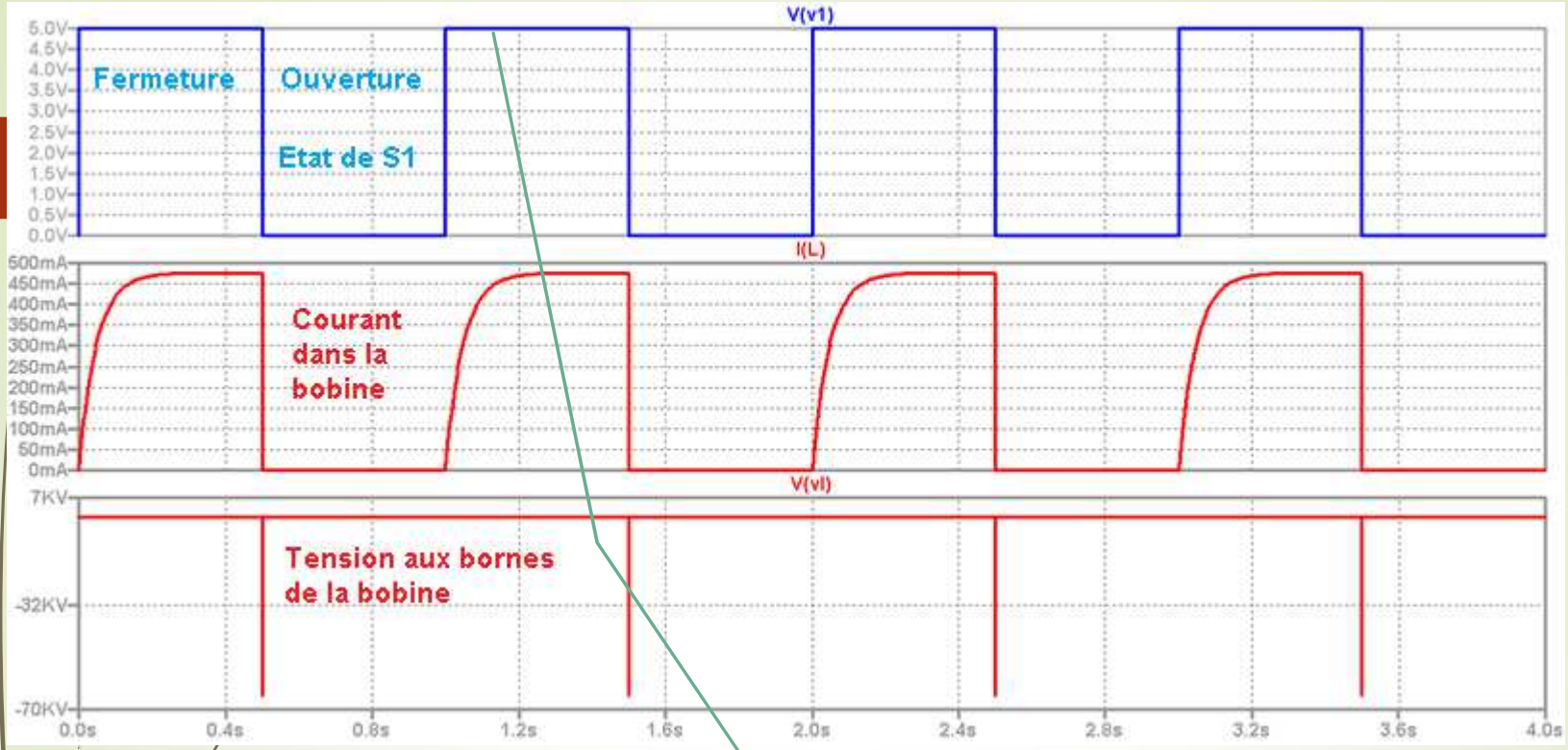
Figure 1 : RL circuit with a time constant of 1/20 second

RL Circuit Response

- The coil opposes any variation in current
- At t=0s, S1 is closed : the current will increase exponentially to its final value :

$$i(t) = \frac{V}{R}(1 - e^{-t/\tau})$$

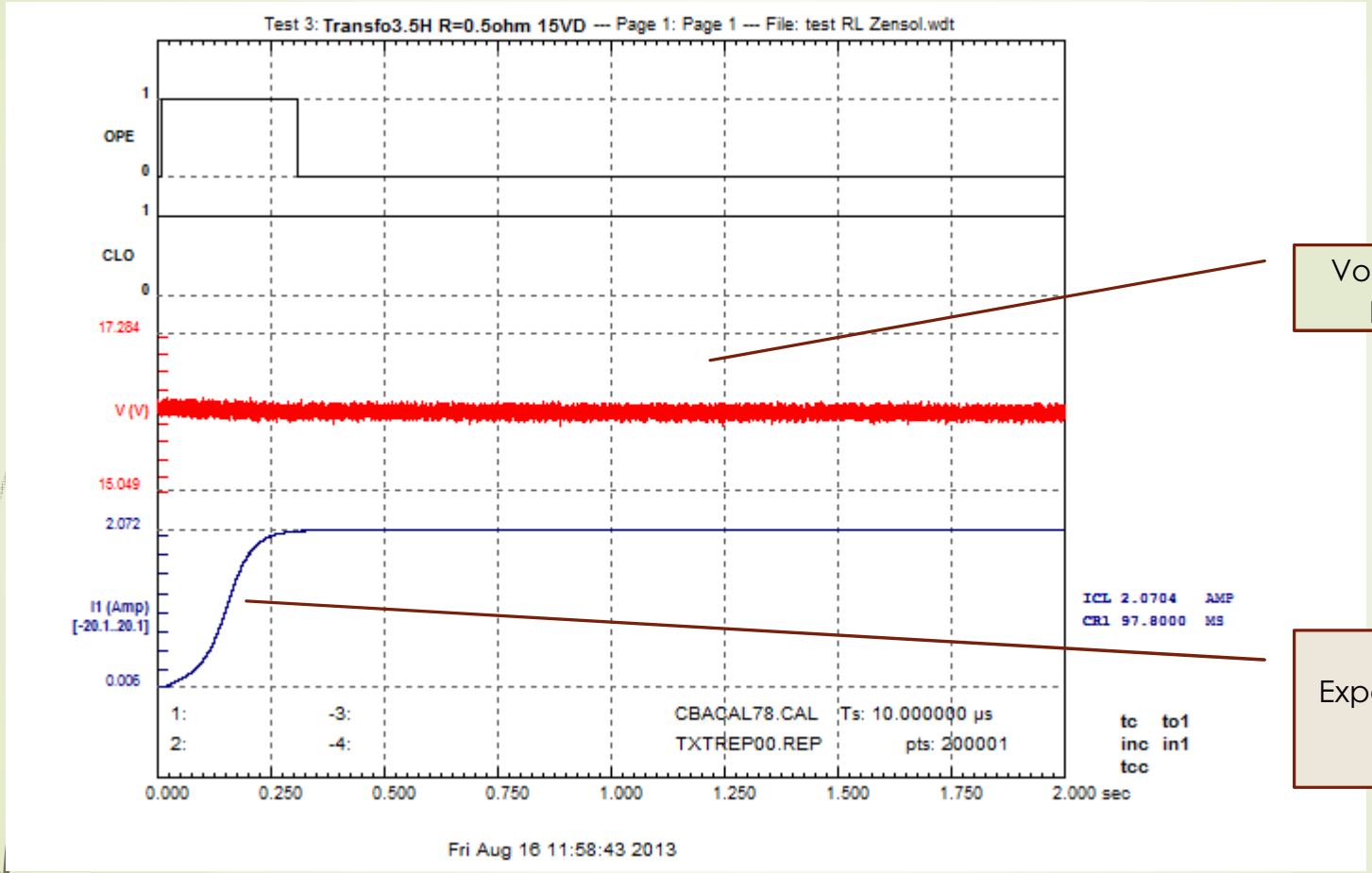
- Where τ is the time constant
- We will be more interested by 5τ : $i(5\tau)=0.9932V/R$



By reducing Ton, we will obtain only a part of the waveform of i(t)

Figure 2 : results of the simulation

RL test, using the cbv

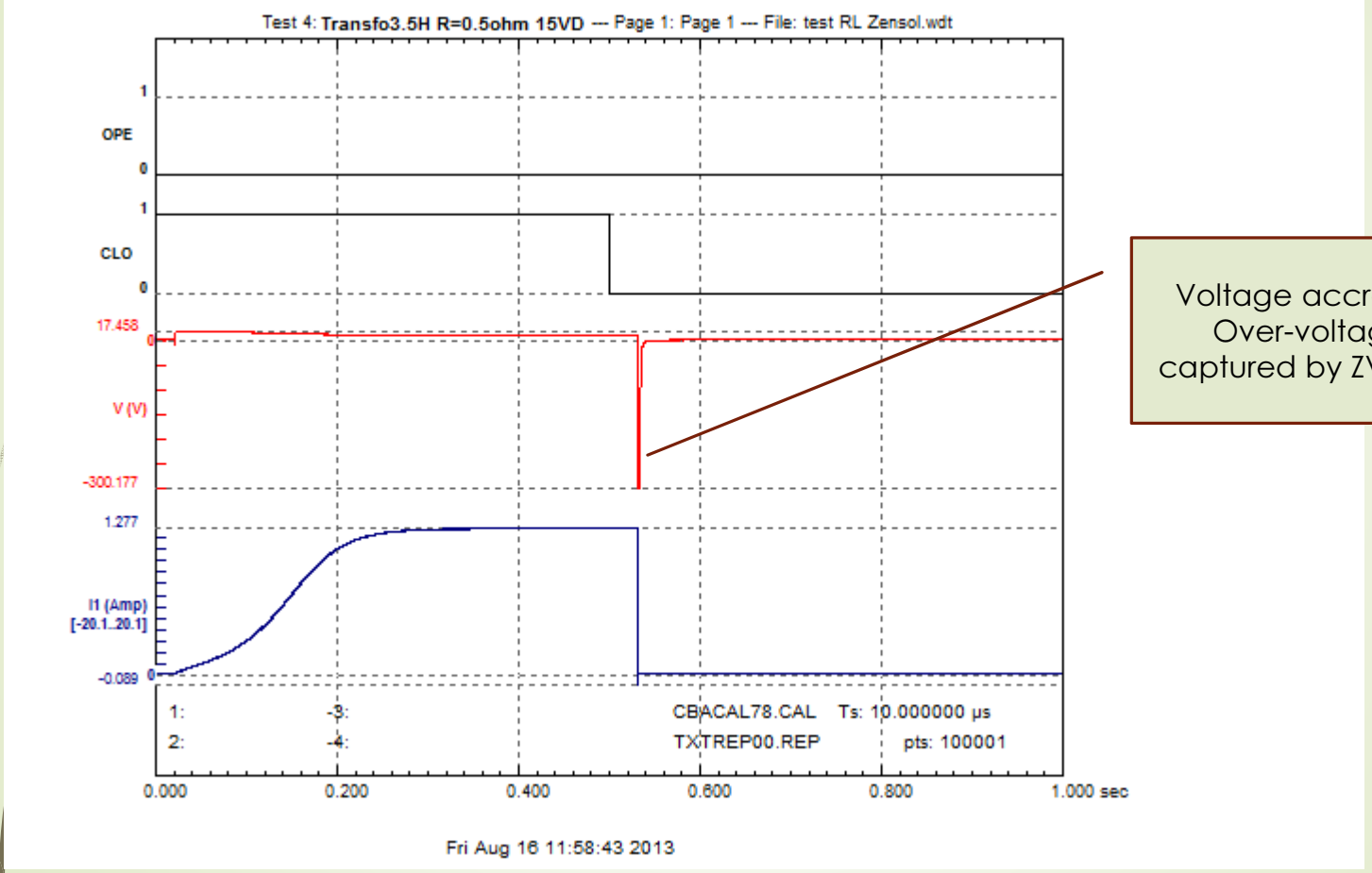


Voltage accros the power supplie

Exponential shape of the curent

Curves shapes, given by CBV-19

Effect of opening an RL circuit



Voltage accros L¨:
Over-voltage
captured by ZVS-300

Over voltage phenomenon: detected by ZVS-300

Adding or removing an RL branch from the circuit

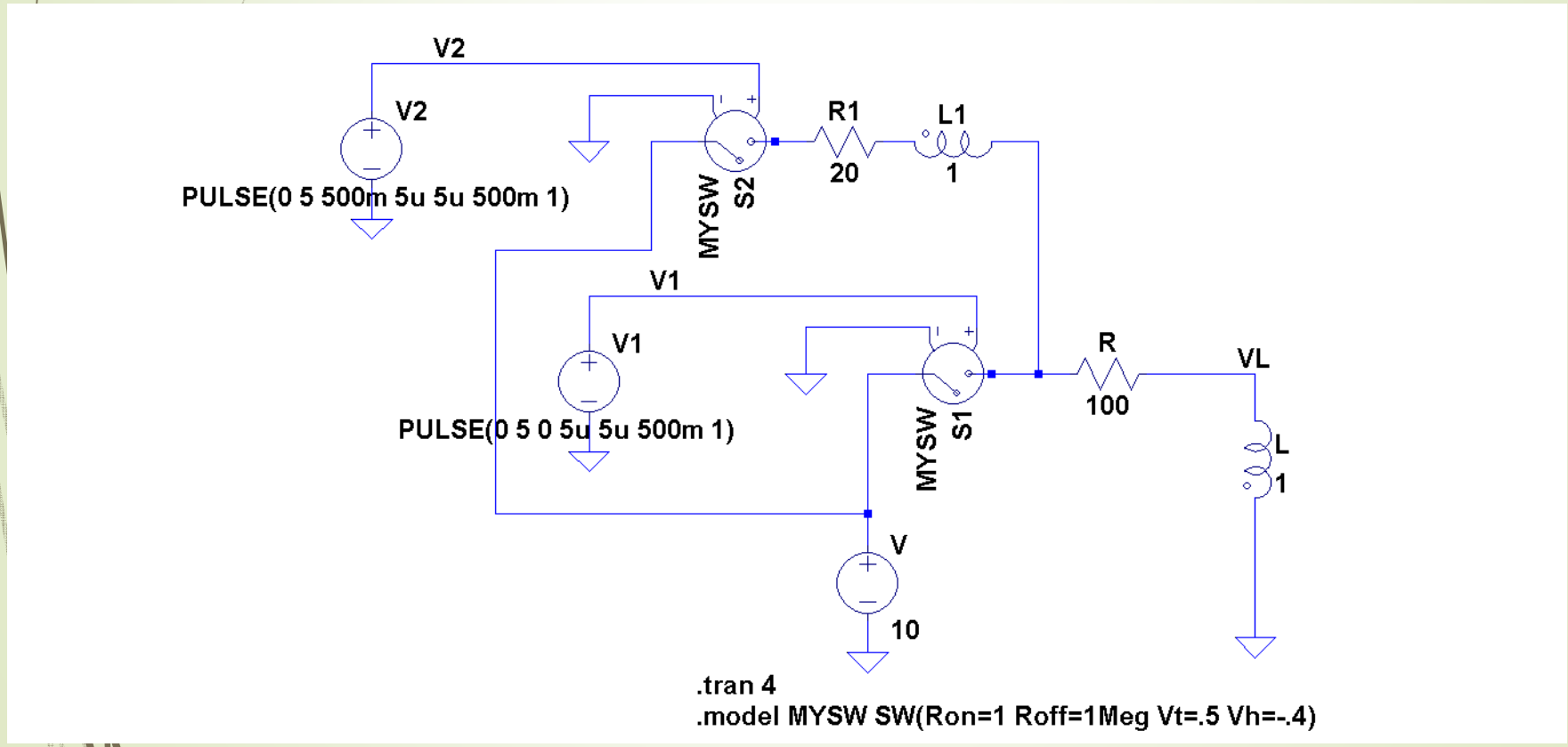


Figure 3 : Adding an RL branch to the circuit

- S1 is closed for 500 ms, then is opened and S2 is closed.

  Since the coil has inertia with respect to current, we see the instant fall of the current, which creates a voltage spike across L.
- The current then increases to its new value, according to the new time constant: L_total/R_total

Adding a resistor only

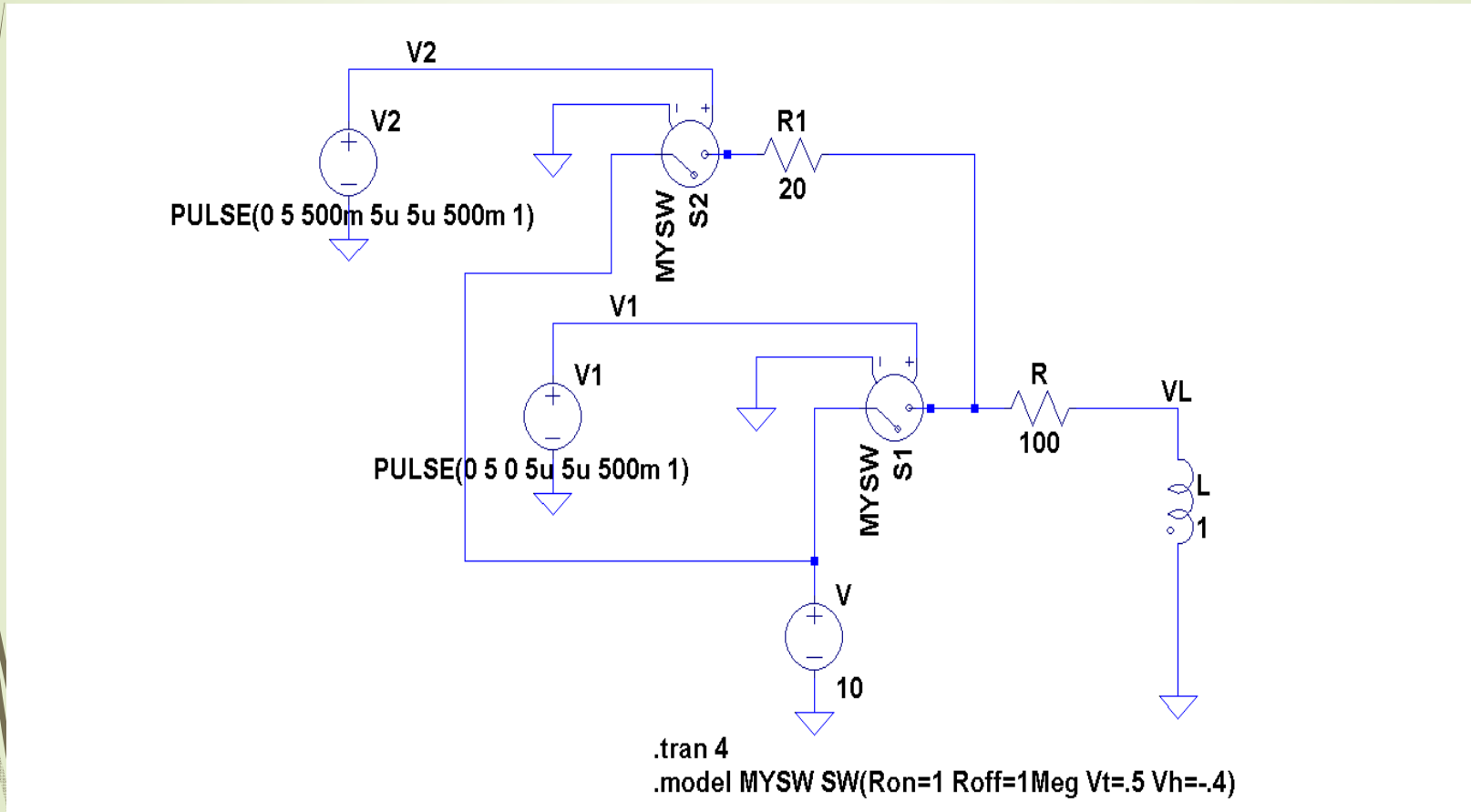


Figure 4 : Adding or removing a resistor to the RL circuit

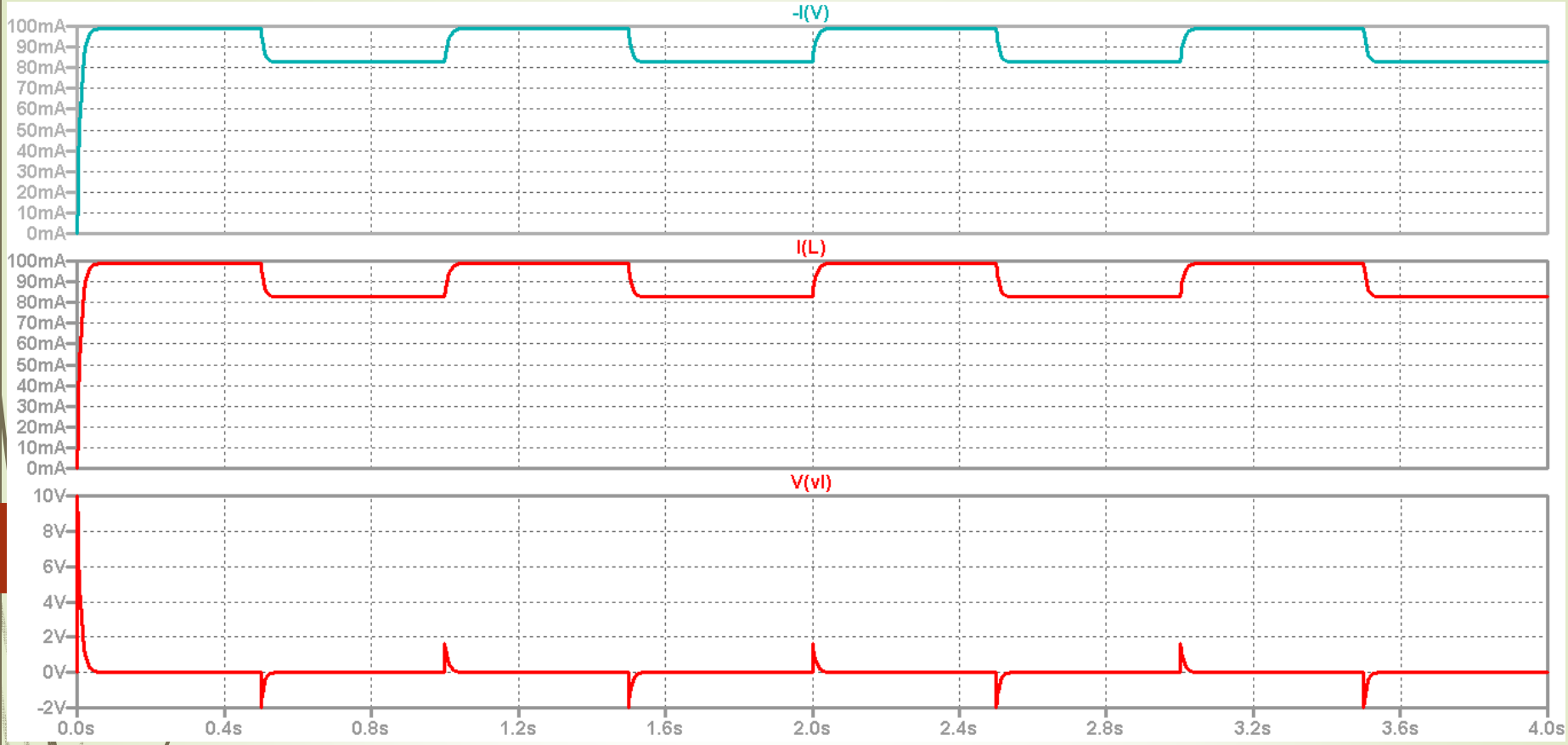
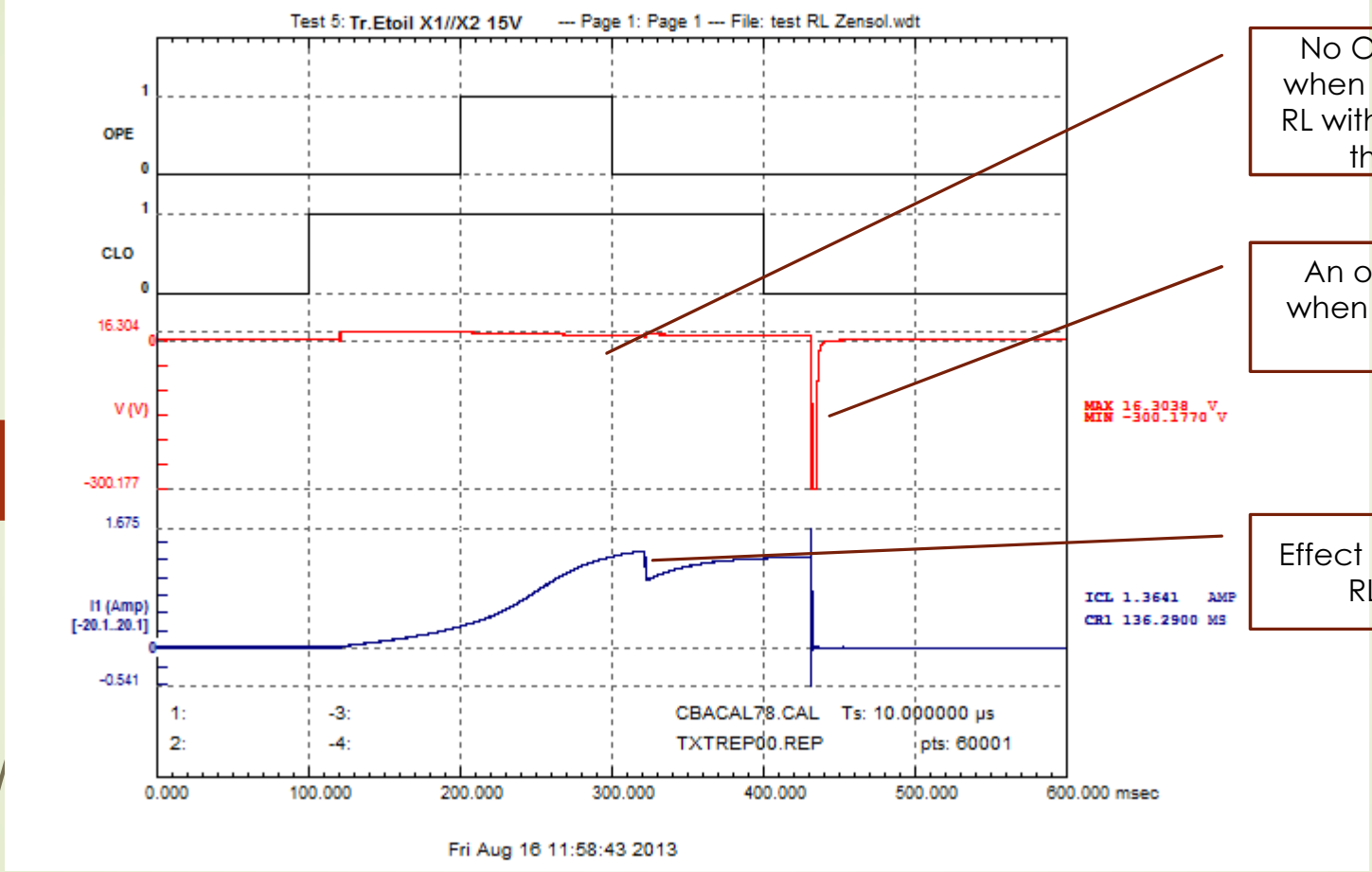


Figure 5 : Effect of adding or removing a resistor from the circuit

THERE IS NO SUDDEN CHANGE IN THE CURRENT, SO THERE IS NO VOLTAGE SPIKE ACROSS THE COIL.

Effect of adding an RL branch to the circuit



No Over voltage when removing an RL without opening the circuit

An over voltage when opening the circuit

Effect of adding an RL branch

Effect of adding an RL branch to the circuit: Tested by CBV-19

Applications to Transformers with Tap Changers

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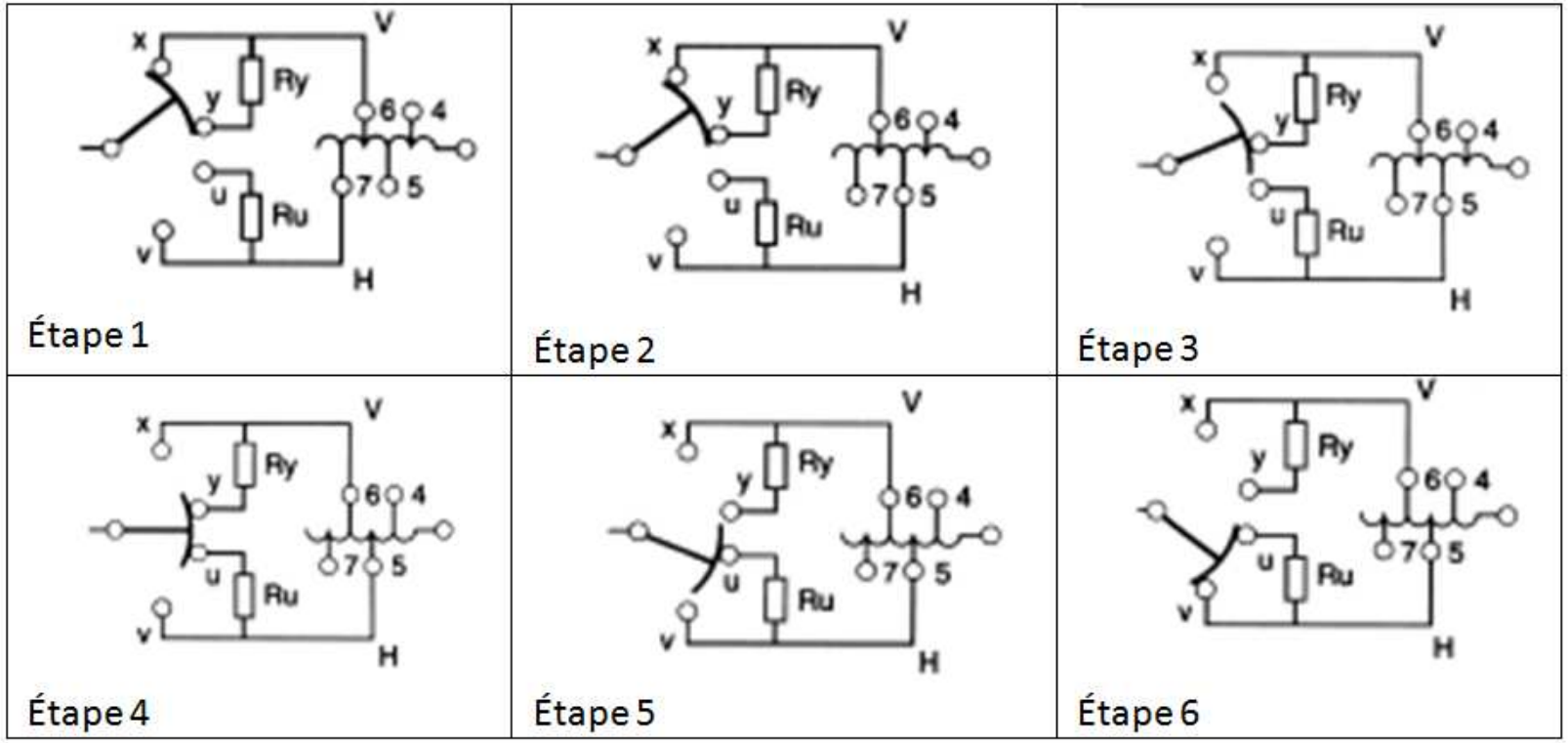
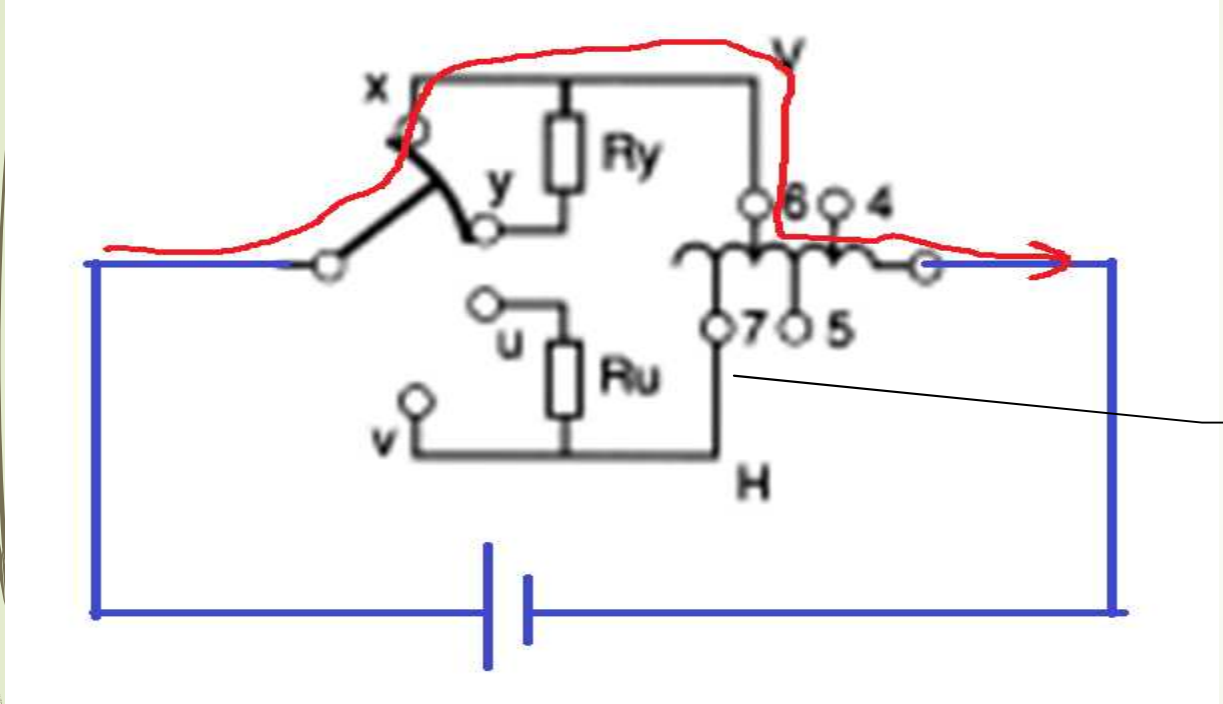
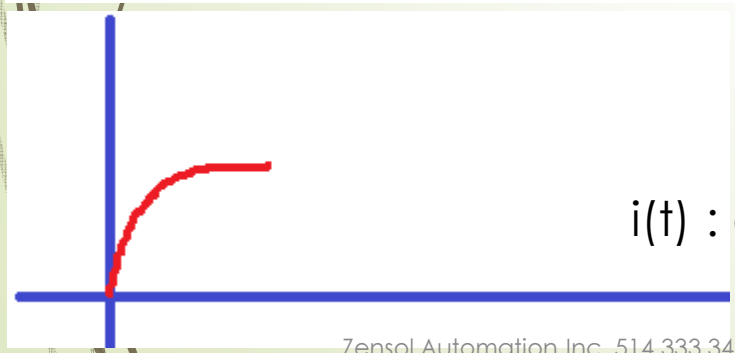
PTCC principle of operation



Step 1

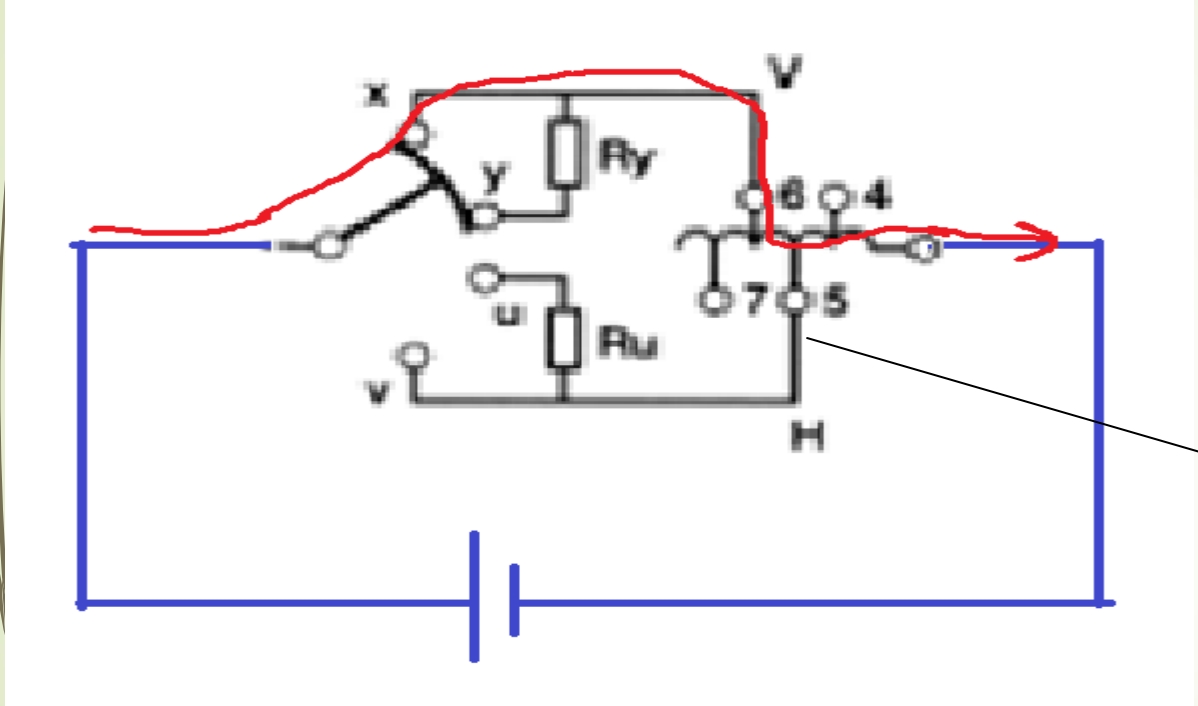


H is in position 7

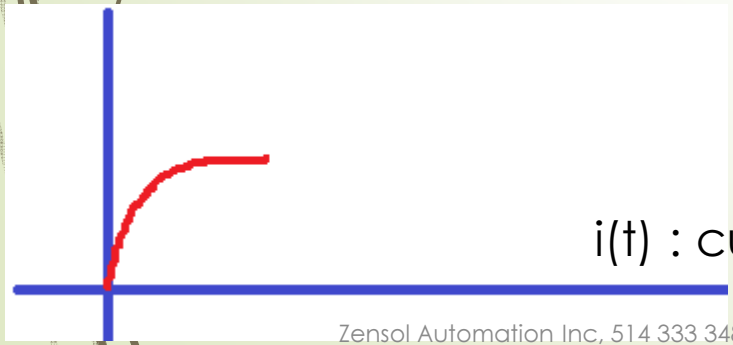


i(t) : current flowing in the circuit

Step 2

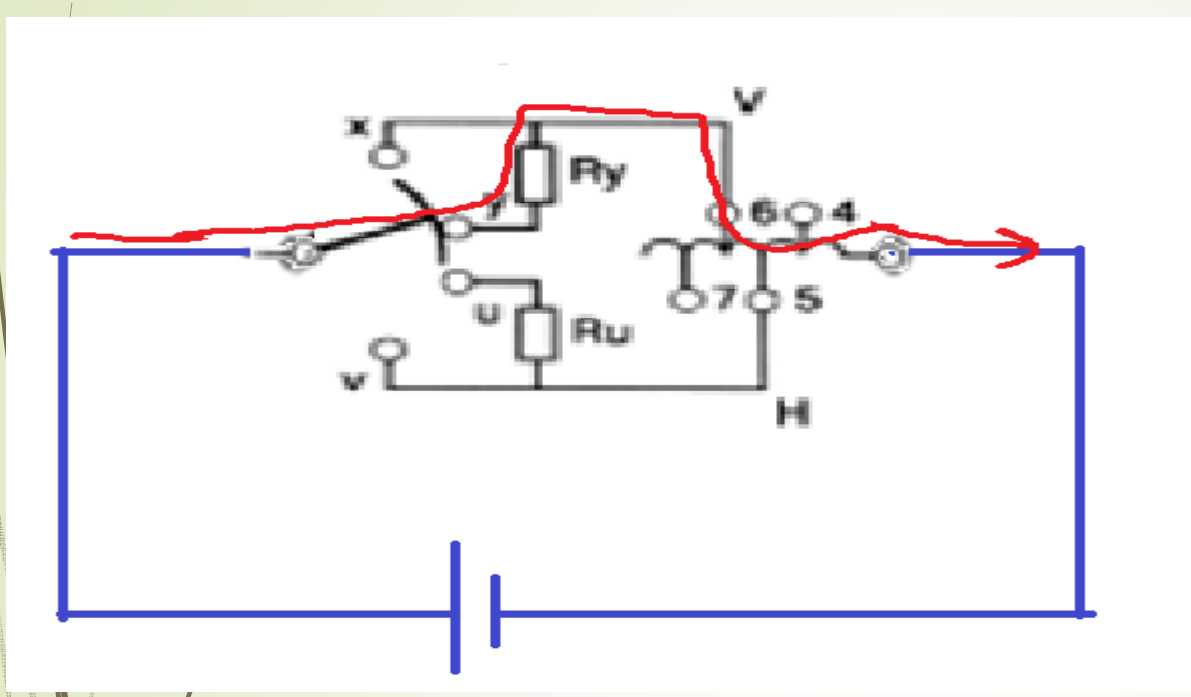


H has moved from 7 to 5
No change in current



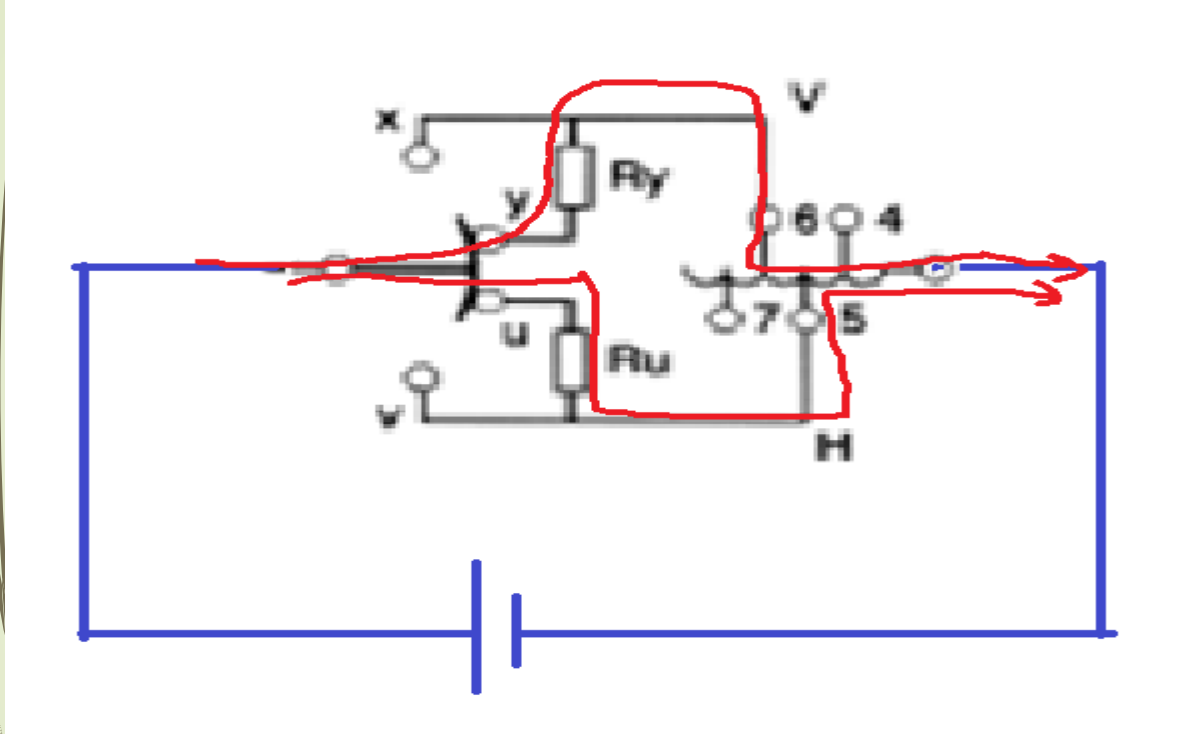
i(t) : current flowing in the circuit

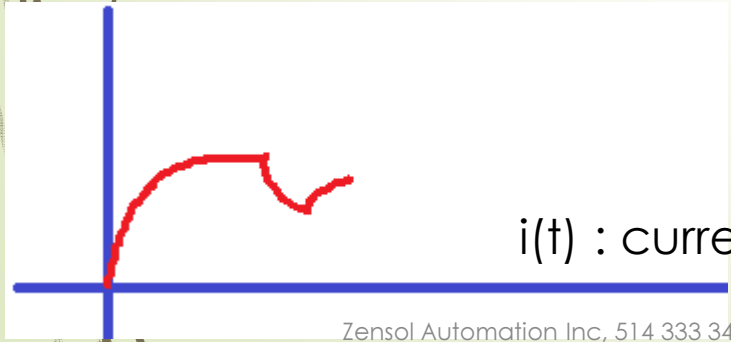
Step 3 : Adding Ry



i(t) : current flowing in the circuit

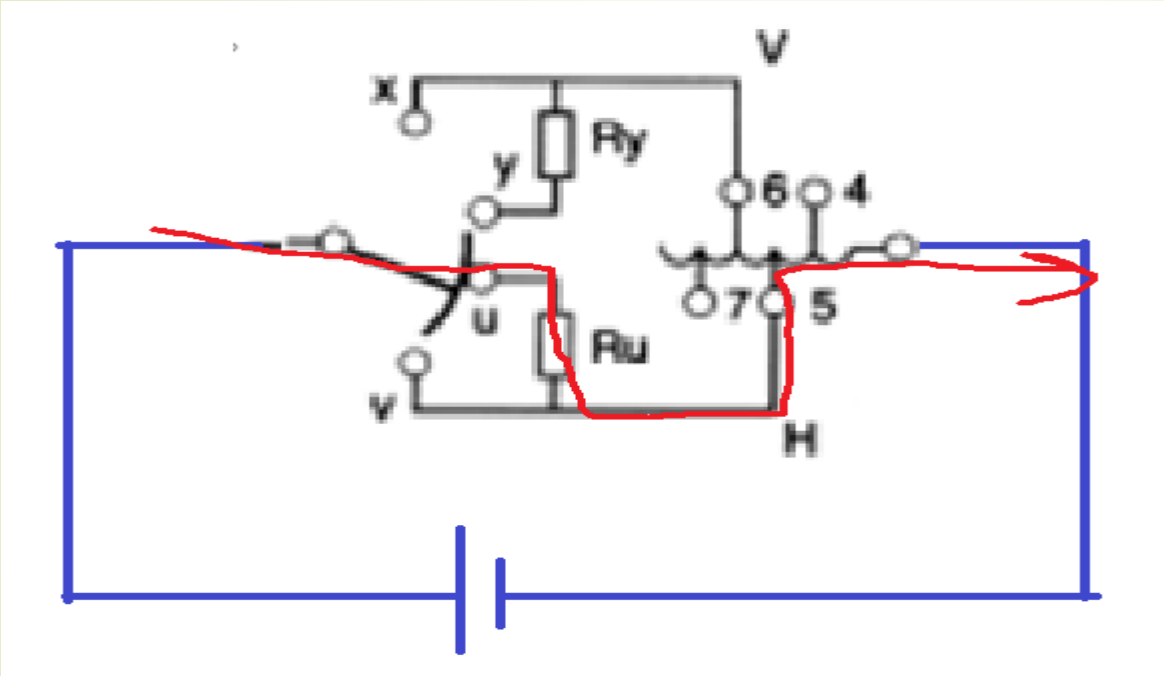
Step 4 : Ry and Ru in parallel

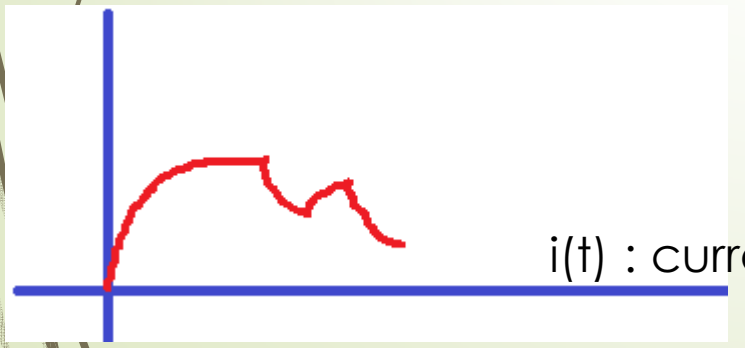




i(t) : current flowing in the circuit

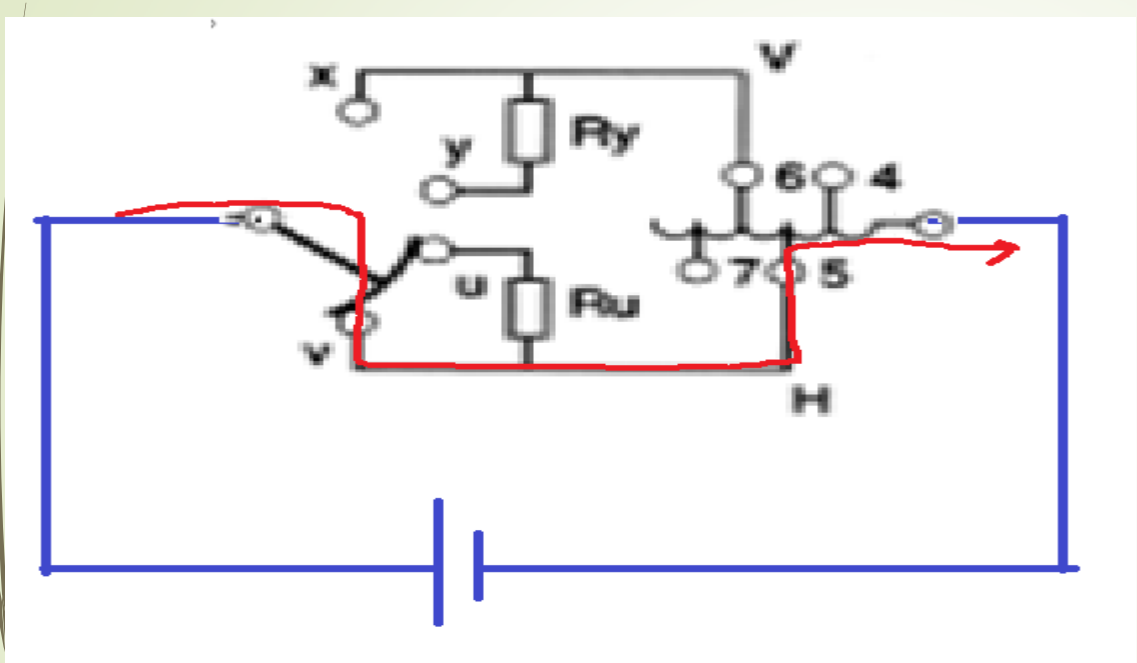
Step 5: removing Ry from the circuit

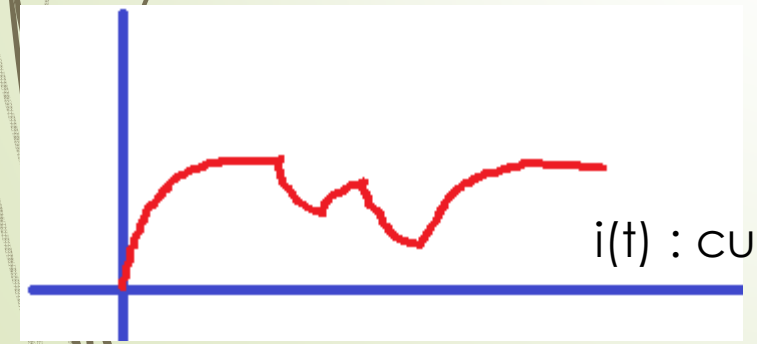




i(t) : current flowing in the circuit

Step 6 : removing Ru





i(t) : current flowing in the circuit