
TOOL: Laplace transformed circuit elements may be expressed in Thevenin equivalent or Norton equivalent form. The sources in the models create initial conditions instantaneously at time zero. The sources have the following properties:

1) The initial condition sources are always expressed in terms of the energy variable for the device. ($i_L(0^-)$ or $v_C(0^-)$). Energy is $w = \frac{1}{2}Li^2$ or $w = \frac{1}{2}Cv^2$.

2) The values of initial condition sources come from the circuit itself. That is, they cannot be derived from a manipulation of *s*-domain information.

3) Since energy variables don't change instantly in a circuit, $i_L(0^+) = i_L(0^-)$ and $v_C(0^+) = v_C(0^-)$ in the actual circuit. So either the 0^+ or the 0^- value from the circuit may be used.

4) In the *s*-domain, *L*'s and *C*'s start out with initial conditions equal to zero at $t = 0^-$, and the initial condition sources instantly create values that appear in the circuit at $t = 0^+$. The energy stored in an *L* or *C* changes instantly in the world of Laplace transformed circuits. Thus, trying to use the values of $i_L(0^-)$ or $v_C(0^-)$ from the *s*-domain representation should be approached with caution.

5) If the type of initial condition source is the energy variable for the device (i_L or v_C), then the source is the initial condition divided by *s*: $i_L(0^-)/s$ or $v_C(0^+)/s$. In the time domain, the source corresponds to a step function that turns on at time zero to create initial conditions. The source remains on forever.

6) If the type of initial condition source is not the energy variable for the device, then the source is the initial condition multiplied by the component value: $Li_L(0^-)$ or $Cv_C(0^+)$. In the time domain, the source corresponds to a delta function that fires at time zero to create initial conditions and then disappears.

7) If the initial condition source is a current source, it is placed in parallel with the component. If the initial condition source is a voltage source, it is placed in series with the component.

8) If the source type is the same as an energy variable, (i.e., the source is current for *L* or voltage for *C*), then the polarity of a source is the same as the polarity of the measurement of the energy variable .

9) If the source type is not the same as an energy variable, then the polarity of a source is opposite the polarity of the measurement of the energy variable.

10) A component with a voltage source for initial conditions is the Thevenin equivalent of a component with a current source for initial conditions, and a component with a current source for initial conditions is the Norton equivalent of a component with a current source for initial conditions.