The Thévenin Equivalent Circuit

A Thévenin equivalent circuit consists of a voltage source ($V_{\text{Th}}(t)$) in series with an impedance (Z_{Th}) and two terminals, **A** and **B**, as shown in Figure 1.

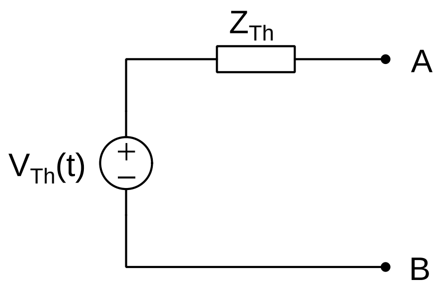

Figure 1: Thévenin equivalent circuit.

Any two terminals, **A** and **B**, in an arbitrary circuit can be represented by a Thévenin equivalent circuit. To compute the Thévenin equivalent circuit:

1. Calculate the open circuit voltage ($V_{\text{AB}}(t)$) between terminal **A** and terminal **B**. This calculation can be performed using KVL, KCL, Ohm's law, nodal analysis, mesh analysis, source transformations or any combination of these. The Thévenin equivalent voltage is equal to this open circuit voltage: $V_{\text{Th}}(t) = V_{\text{AB}}(t)$.

2. Deactivate all independent voltage sources and independent current sources in the circuit. Independent voltage sources are replaced with short circuits; independent current sources are replaced with open circuits. Calculate the Thévenin equivalent impedance (Z_{Th}) by one of the three methods below:

   (a) Attach an independent "test" voltage source ($V_{\text{test}}(t)$) or an independent "test" current source ($I_{\text{test}}(t)$) between terminal **A** and terminal **B**. Calculate the current through $V_{\text{test}}(t)$, or the voltage across $I_{\text{test}}(t)$. Z_{Th} is the impedance seen by the "test" source: $Z_{\text{Th}} = V_{\text{test}}(t)/I_{\text{test}}(t)$. To simplify the calculations, set the "test" source voltage or current to 1.

   (b) If the circuit does not contain any dependent voltage sources or dependent current sources, calculate the equivalent impedance between terminal **A** and terminal **B**. Z_{Th} is equal to this equivalent impedance.

   (c) If the Thévenin equivalent voltage ($V_{\text{Th}}(t)$) and the Norton equivalent current ($I_{\text{N}}(t)$) (see page 2) are both known, then: $Z_{\text{Th}} = V_{\text{Th}}(t)/I_{\text{N}}(t)$.

The Norton Equivalent Circuit

A Norton equivalent circuit consists of a current source ($I_{\text{N}}(t)$) in parallel with an impedance (Z_{N}) and two terminals, **A** and **B**, as shown in Figure 2.

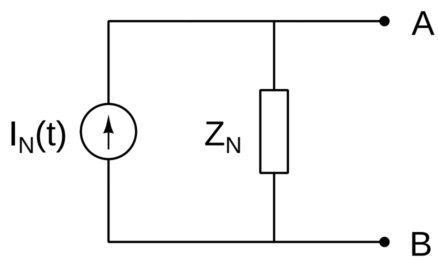

Figure 2: Norton equivalent circuit.

Any two terminals, **A** and **B**, in an arbitrary circuit can be represented by a Norton equivalent circuit. To compute the Norton equivalent circuit:

1. Calculate the short circuit current ($I_{\text{AB}}(t)$) between terminal **A** and terminal **B**. This calculation can be performed using KVL, KCL, Ohm's law, nodal analysis, mesh analysis, source transformations or any combination of these. The Norton equivalent current is equal to this short circuit current: $I_{\text{N}}(t) = I_{\text{AB}}(t)$.
2. The Norton equivalent impedance (Z_{N}) is equal to the Thévenin equivalent impedance (Z_{Th}). Calculate Z_{Th} as described in step 2 on page 1 in "The Thévenin Equivalent Circuit."

Notes:

The Norton equivalent circuit is the source transformation of the Thévenin equivalent circuit. Applying the source transformation: $I_{\text{N}} = \frac{V_{\text{Th}}}{R_{\text{Th}}}$ and $R_{\text{N}} = R_{\text{Th}}$.

The Thévenin equivalent circuit is the source transformation of the Norton equivalent circuit. Applying the source transformation: $V_{\text{Th}} = I_{\text{N}} R_{\text{Th}}$ and $R_{\text{Th}} = R_{\text{N}}$.