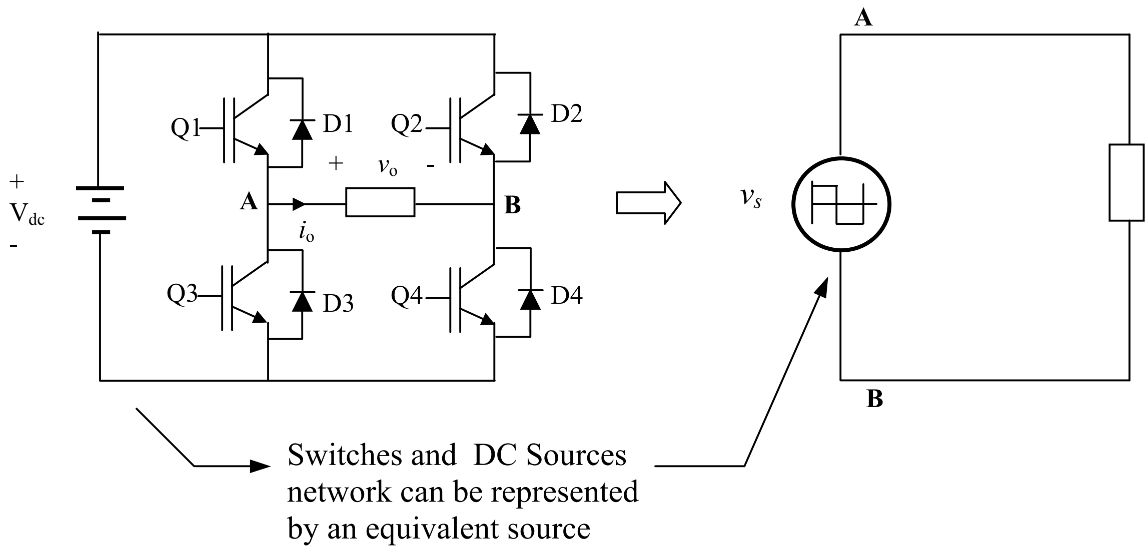
Inverter:
Equivalent sources and Fourier series



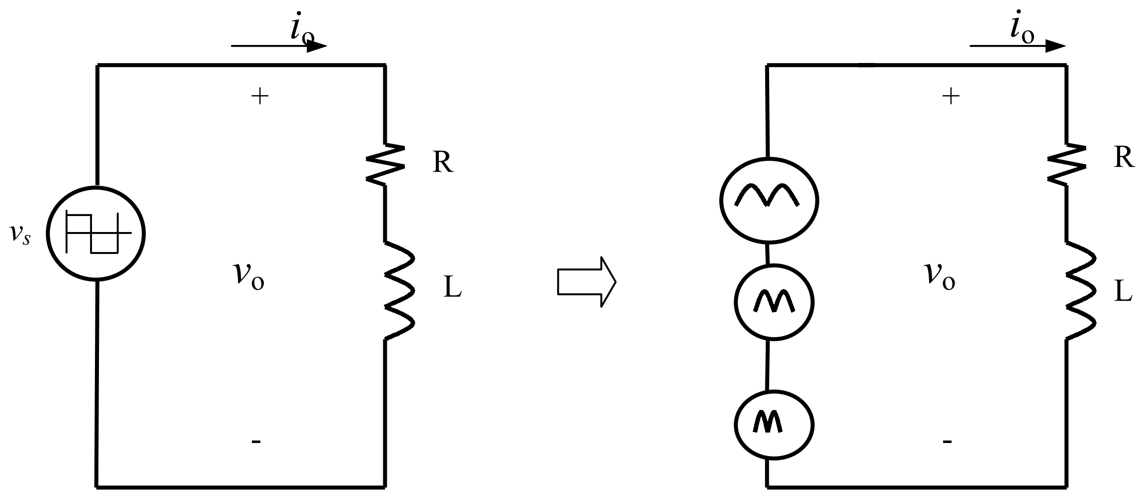
In the inverter circuits, a DC source is processed through a set of switches to create a well-defined waveform (SW, QSW, U-SPWM, B-SPWM, Six-step waveforms).

We can represent the combined action of an actual source (DC source) and a set of switches by an equivalent source.

The equivalent sources provide a very strong advantage: The new circuits are linear, and avoid the nonlinearity and complication of switches. We can use superposition, Laplace transforms, or other techniques from linear network analysis to solve for $i(t)$.

Based on superposition, a term-by-term for the Fourier series of the current in the inverter circuits can be solved.

Special case: Equivalent Source applied to RL Load



The Fourier series for the voltage $v_o(\omega t)$ can be expressed in trigonometric form as

$$v_o(\omega t) = \sum_{n=1}^{\infty} V_n \sin n\omega t$$

The load impedance at harmonic n $Z_n = \sqrt{R^2 + (n\omega L)^2}$

The amplitude of each voltage terms V_n

The amplitude of each current term $I_n = \dfrac{V_n}{Z_n}$

The rms current $I_{rms} = \sqrt{\sum_{n=1}^{\infty} I_{n,rms}^2} = \sqrt{\sum_{n=1}^{\infty} \left(\dfrac{I_n}{\sqrt{2}}\right)^2} = \sqrt{\sum_{n=1}^{\infty} \dfrac{I_n^2}{2}}$

The rms voltage $V_{rms} = \sqrt{\sum_{n=1}^{\infty} V_{n,rms}^2} = \sqrt{\sum_{n=1}^{\infty} \left(\dfrac{V_n}{\sqrt{2}}\right)^2} = \sqrt{\sum_{n=1}^{\infty} \dfrac{V_n^2}{2}}$

Power at each component is, $P_n = I_{n,rms}^2 R$

Total power absorbed by the load, $P = \sum_{n=0}^{\infty} P_n = I_{rms}^2 R$

The THD of voltage $THD_v = \dfrac{\sqrt{\sum_{n=2}^{\infty} (V_{n,rms})^2}}{V_{1,rms}} = \dfrac{\sqrt{V_{rms}^2 - V_{1,rms}^2}}{V_{1,rms}}$

The THD of current $THD_I = \dfrac{\sqrt{\sum_{n=2}^{\infty} (I_{n,rms})^2}}{I_{1,rms}}$

Do it yourself:

Example 8.2, Example 8.3, Example 8.7 — Hart.

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