Basic principles of switch-mode power conversion (DC-DC):

**Power balance**

- Bi-positional switch
- PWM and duty ratio
- Cycle-by-cycle averaging
- Concept of DC steady-state
- Volt-sec balance
- Current-sec balance
- Power balance

Neglecting all losses, and in an average (CCA) sense and under steady state, input power equals output power

\[ P_{in} = P_{out} \]

\[ P_{int} = (V_{in} I_{in}) = P_{int} = (V_{in} I_{in}) \]

Power balance is valid at intermediate stages too

\[ P_{in} = P_{int} = P_{out} \]

in steady-state and with no losses

- In general, for a port with switching voltages and currents,
  \[ P_{in} = V_{in} I_{in} \]
  
- Need to be careful in writing
  \[ P_{int} = (V_{int} I_{int}) \]

Example

Given that the circuit is in DC steady state, and that the circuit inside the block 'Valid network' has no sources, loads or loss, calculate \( V_{o} \)

Input-output power balance

- Neglecting all losses, and in an average (CCA) sense and under steady state, input power equals output power

\[ P_{in} = P_{out} \]

\[ P_{in} = (V_{in} I_{in}) = P_{out} = (V_{o} I_{o}) \]

- In general, for a port with switching voltages and currents,
  \[ P_{in} = V_{in} I_{in} \]
  \[ P_{out} = V_{o} I_{o} \]

Example

Calculate \( I_{o} / I_{in} \) in terms of the duty ratio, \( d \) given the inductor voltage below

\[ V_{i} \]

\[ \frac{I_{o}}{I_{in}} = \frac{1-d}{d} \]