Closed-Loop Bridge Converter Switching and Averaged Models

**ATP Version**

**DC-DC Converter Example**

- The $k_i$ and $k_p$ should be tuned for the $R_s$ and $L_s$ values of this system.

As per page 51 in the textbook by Yazdani and Iravani:

- Desired time constant: $\tau_i = 0.005$
  
  $R_S = 0.00588$  
  $L_S = 0.69 \cdot 10^{-3}$

  We know that: 
  $\frac{k_i}{k_p} = \frac{R_S}{L_S}$ and $\frac{k_p}{L_S} = \frac{1}{\tau_i}$

  So: 
  $k_p = \frac{L_S}{\tau_i}$  
  $k_p = 0.138$  
  $k_i = \frac{R_S}{L_S}$  
  $k_i = 1.176$

- Switching and averaged models match, but
- Poor current tracking at startup and for changes
- And for changing conditions
Here are the current reference and current from the averaged model.

Add feedforward term, VS2.

Now much better tracking at startup.
Can see the effect of time constant in the transition between setpoints.
- modulation function

- output of PI (red)
- output of PI + voltage
- feedforward input (green)
**DC-AC Application**

Create sinusoidal $i_{\text{ref}}(t)$ function

- Significant tracking problem
- Trying to track a time varying reference
Try lowering the time constant of the PI loop:

- New desired time constant: \( \tau_i := 0.0005 \)

So: \( k_p := \frac{L_S}{\tau_i} \)

\[ k_p = 1.38 \]

\( k_i := k_p \cdot \frac{R_S}{L_S} \)

\[ k_i = 11.76 \]

Now tracks magnitude

Still have a phase error that would require additional compensation

There are other PWM schemes we could use as well
• Note that modulating function hits limits during the higher current output state

• Due to the high current reference

• Converter terminal voltage from switched and averaged models