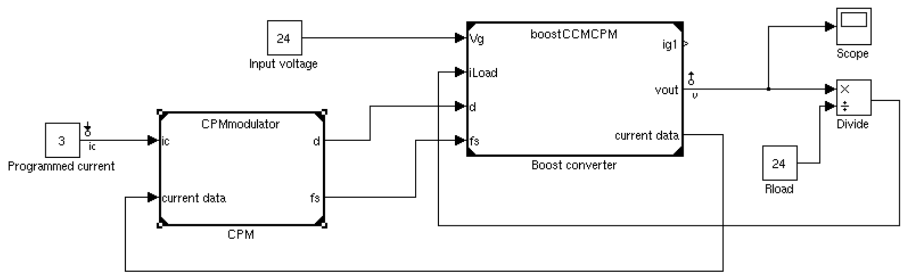
Current mode control model: Simulink



- Use same power stage models previously described
- Need new model for CPM controller
- A single CPM controller model can be used with any power stage

Simulink model: CPM controller block

From Tan model: equation of the CPM modulator

$$\langle i_L \rangle = d' i_1 + d i_2 = i_c - m_a d T_s - \frac{m_1 + m_2}{2} d d' T_s$$

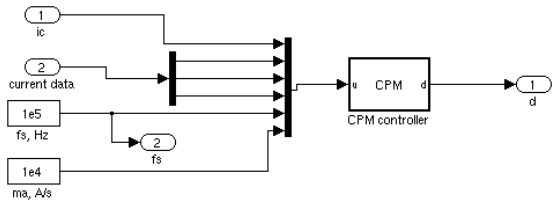
The CPM modulator effectively solves this equation for $d(t)$; the following is the CCM solution:

$$d(t) = b\left[1 - \sqrt{1 - \frac{2 f_s\left(i_c - \langle i_L \rangle\right)}{b^2\left(m_1 + m_2\right)}}\right]$$

$$\text{with} \quad b = \frac{m_a}{\left(m_1 + m_2\right)} + \frac{1}{2}$$

The modulator model must therefore evaluate this equation.

CPM controller model, Simulink



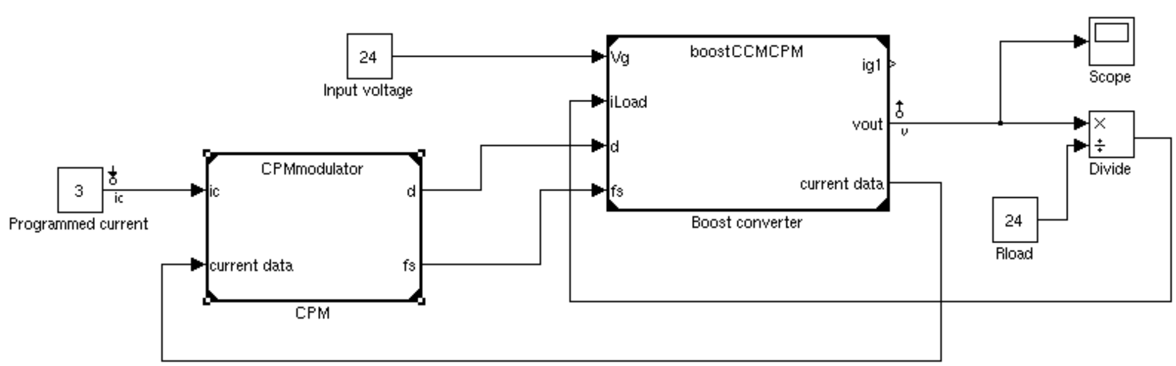
$$d(t) = b\left[1 - \sqrt{1 - \frac{2 f_s\left(i_c - \langle i_L \rangle\right)}{b^2\left(m_1 + m_2\right)}}\right]$$

$$\text{with} \quad b = \frac{m_a}{\left(m_1 + m_2\right)} + \frac{1}{2}$$

```
1   function d = CPM(u)
2   %#eml
3   % Current mode controller, using Tan's model
4   % No sampling dynamics included
5   ic = u(1); % control current
6   i = u(2);  % average inductor current
7   m1 = u(3);  % inductor up slope
8   m2 = u(4);  % inductor down slope
9   fs = u(5);  % switching frequency
10  ma = u(6);  % slope of artificial ramp
11  b = ma/(m1+m2) + 0.5;
12  d = max(0,min(0.9,b*(1-sqrt(1-(ic-i)*2*fs/(m1+m2)/b^2)))); % duty cycle computation, including modulator saturation limits
```

- The slopes m_a, m_1, m_2 are supplied by the converter power stage, via the vector "current data"
- Lines 11-12 evaluate the solution for $d(t)$ from previous slide
- Line 12 also includes saturation limits for $d(t)$

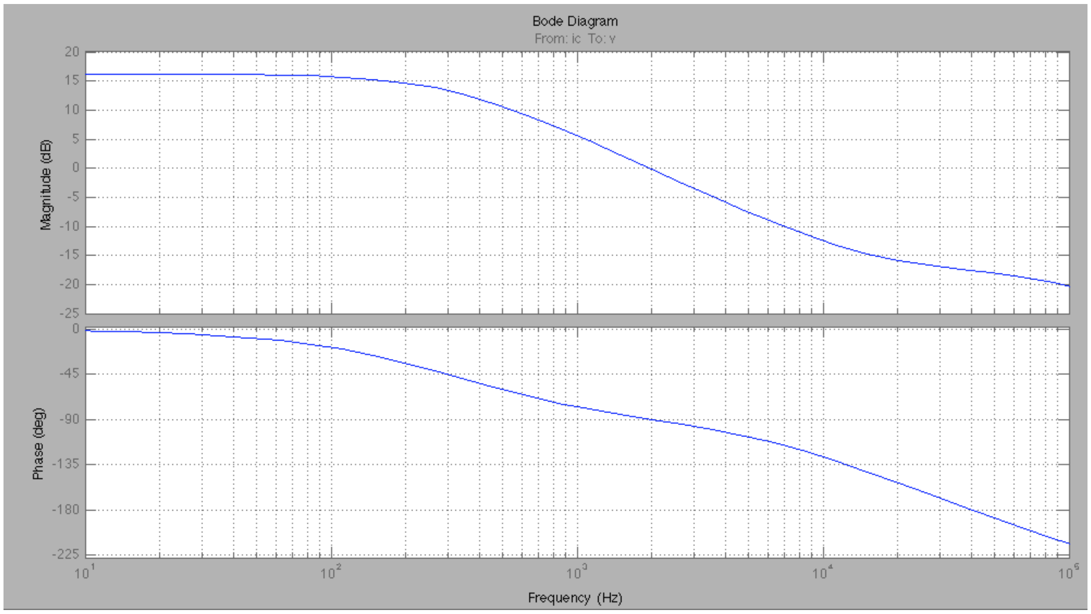
Example: a current-mode boost converter



Setup to plot control-to-output transfer function is shown; results on next slide

Control-to-output transfer function / Simulink

CPM boost, previous slide



Plotting the output impedance / Simulink

CPM boost, previous slides