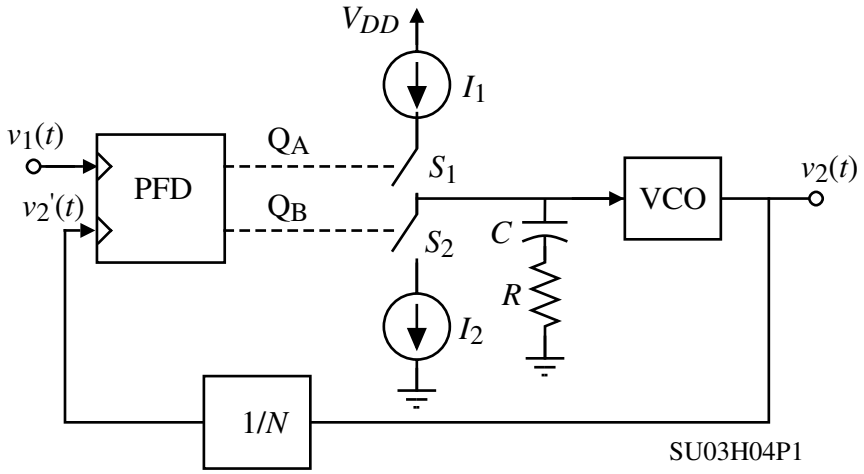
Homework Assignment No. 4

This homework assignment is due in class on Wednesday, June 11, 2003.

Problem 1 - (10 points)

For the DPLL shown assume that $N = 1000$ and the –3dB bandwidth is 1000 Hz. (a.) Assume that $\zeta = 0.2$ and solve for the natural pole frequency, ω_n, the filter time constant, $\tau = RC$, and the phase margin. (b.) Repeat part (a.) if $\zeta = 0.7$. (c.) Repeat part (a.) if $\zeta = 1$. Verify your answers with PSPICE.



Problem 2 – (10 points)

A type-I, second-order DPLL synthesizer is to be made with components having the following values:

$K_o = 4\text{x}10^8$ rads/sec./V $\quad f_{ref} = 12.5$ kHz $\quad K_d = 0.15$ V/rad $\quad \beta = 2\pi$

Design a type-I, second-order synthesizer having the following specifications:

1.) Output frequency range = 50MHz

2.) Lock range = 10MHz at the output

3.) Damping factor = 0.75.

Determine the components for the loop filter. Let $C = 0.5\mu$F. Make a sketch of your filter with all components carefully labeled. Once your design is complete, determine the pull-in range in Hz (at the output) and the lock time of your loop.

Problem 3 – (10 points)

Given the DPLL described by

$$K_d = 2.2 \text{ V/rad} \qquad F(s) = \frac{1+\tau_2 s}{1+\tau_1 s} = \frac{1+5\text{x}10^{-6}s}{1+2\text{x}10^{-5}s}$$

$f_{ref} = 12$ kHz $\quad K_o = 25$ MHz/V $\quad \beta = 2\pi \quad N = 15{,}000$

Determine the type number and order of the system and then find:

(a.) The output frequency in Hz.

(b.) The crossover frequency in Hz.

(c.) The noise bandwidth (Hz).

(d.) The closed-loop phase –3dB bandwidth in Hz

(e.) The steady-state phase error in response to a phase step of 0.1 radian.

(f.) The hold range (±Hz at the output).

(g.) The lock range (±Hz at the output).

(h.) The lock time.

(i.) The pull-in range (±Hz at the output)

(j.) The steady-state phase error in radians in response to a frequency step equal to the lock range.

Problem 4 – (10 points)

Construct an accurate Bode plot of the synthesizer in Problem 3. Use this Bode plot to determine the phase margin.

Problem 5 – (10 points)

Write the transfer functions giving: (1) The VCO phase noise in the output, (2) the reference oscillator phase noise in the output. Use the literal form of the equations. The phase noise of the VCO used in the synthesizer of Problem 3 is shown below. Make an accurate plot of the VCO phase noise in the output of the synthesizer.