Linköping University
Martin Nielsen-Lönn
Integrated Circuits and Systems, ISY

Exercies for Tutorial 6: Timing issues

1. Assume that an inverter stage can be approximated as a first-order circuit with a single pole at ω_0 and a stage gain of $-A$. Determine the open-loop transfer function of a 5-stage ring oscillator. Calculate the minimum required voltage gain per stage in order to have oscillation.

2. A voltage-controlled oscillator with linear tuning characteristic has a gain of $2\pi \times 10^8 \frac{rad}{s}/V$. The control voltage varies between 0 and $3\ V$. When the control voltage is $0.5\ V$, the oscillation frequency is $1\ GHz$. Calculate the required control voltage to get $1.25\ GHz$ oscillation frequency.

3. Consider the PLL loop filter circuit shown in Figure 13. Determine the transfer function $G(s)$ of this filter. The op-amp is ideal.

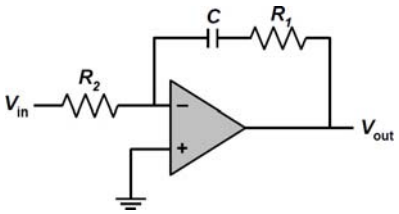

Figure 13 Loop filter circuit.

4. A block diagram of a PLL is shown in Figure 14. φ_{in} is the reference phase and φ_{out} is the output of the oscillator. The following relations can be identified:

$$V_1 = K_{PD}(\varphi_{in} - \varphi_{out})$$
$$\frac{d\varphi_{out}}{dt} = K_{VCO}V_2$$

   a) Determine the closed-loop transfer function of the PLL from φ_{in} to φ_{out}. Use the loop filter transfer function $G(s)$ in problem 3.

   b) What are the necessary conditions on K_{PD} and K_{VCO} for stability?

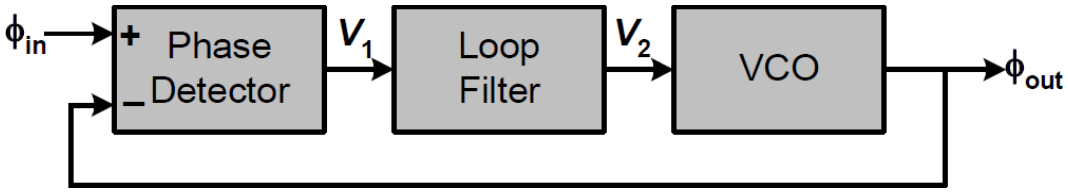

Figure 14 PLL block diagram.