

Optimization Techniques for Design of General and Feedback Linear Analog Amplifiers with Symbolic Analysis

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The analysis of linear analog amplifiers at the beginning of the design process shows in some cases an unwanted resonance in the amplitude response or an unwanted overshooting in the time domain. It is important for the designer to know design methods for compensating this effect.

An approach of the symbolic analysis, that supports the representation of a signal-flow graph with feedback for an amplifier circuit, will be introduced. The method is based on the node analysis and mathematical handling of symbolic expressions. Using the proposed approach the feedback, the open-loop gain and the loop gain can be analyzed and calculated. With the analysis of pole-zero of the symbolic loop gain, parameters of the amplifier can be determined for the compensation of the amplitude response.

A system of symbolic modified nodal small-signal equations (MNA) of an amplifier circuit can be set up as

$$\underline{A} \cdot \underline{x} = \underline{b}, \quad a_{1j} \neq 0, \quad 1 \leq j \leq n. \quad (1)$$

From these equations (1), the open loop gain is obtained

$$\underline{A} = \frac{\Delta \underline{A}_n}{\Delta \underline{A}_1 \cdot a_{11} + \Delta \underline{A}_2 \cdot a_{12} + \dots + \Delta \underline{A}_{n-1} \cdot a_{1n-1}}, \quad (2)$$

where $\Delta \underline{A}_i$ denotes the determinant of the nodal matrix \underline{A} , whose i -th column has been replaced by the vector \underline{b} .

The feedback factor is

$$\underline{B} = a_{1n}. \quad (3)$$

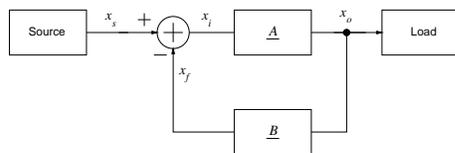


Figure 1. signal-flow graph with feedback

The analyzed circuit example is a compensated CMOS differential amplifier shown in figure 2.

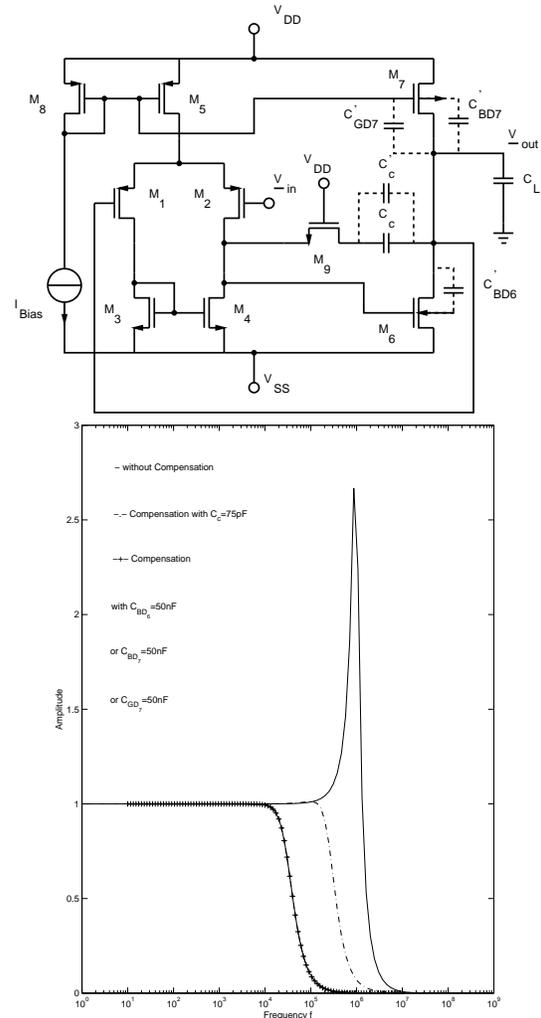


Figure 2. amplitude response of the amplifier

One zero of the loop gain $|\underline{A} \cdot \underline{B}|$ is

$$z_o = \left| \frac{(g_{DS7} + g_{DS6})}{2 \cdot \pi \cdot (C_L + C_C + c_{BD6} + c_{BD7} + c_{GD7})} \right|.$$