1.5 Low-voltage ultra-low-power analog IC design
— switched-MOSFET technique

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Sampled-data Circuits
Three basic elements may be used
Switched-capacitor (SC)
Switched-current (SI)
Switched-resistor (SR)

Switched-MOSFET Sampled-Data Technique for Low-Voltage Supply

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Outline

Switched-MOSFET Sampled-Data Technique

Introduction

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First Conclusions

1. SM does not need any special process or voltage doubler.
2. SM allows independent digital programming of the filter center frequency ($\omega_0$), quality factor ($Q$), and gain.
3. Programming is not area demanding.

4. The SM technique is adequate for the implementation of programmable filters at low-voltage supply.

Some practical issues

1. SM technique relies on opamps. Opamps BW $\geq$ 3.16 (same as for SC circuits) and $A_{Vr/o} > 77 \; \text{dB} \; \text{(linear}} \; \text{early selectable)}$ (for THD $< 0.1\%$).

2. Charge injection will give rise to harmonic distortion. The nonlinearity of the output current is dependent on both the Q-to-V conversion of the holding capacitor and the V-to-I conversion of the MOSFET. Therefore, switches should be minimised.

3. In the SM technique, there are no "natural" integrations as in SC circuits. In SC circuits, inductors are the integrator (variable resistors in the feedback loop of the op amp) and the capacitor is the integrator (variable capacitance). In SM circuits, the inductor is the integrator (variable inductance in the feedback loop of the op amp) and the capacitor is the integrator (variable capacitance). As a consequence of this, the operating range is significantly reduced.

4. Offset-compensation schemes may be used. In this case, the compensation capacitor can be the same size as the holding capacitor, and this cannot be the case in SC circuits.

5. Opamps must drive relative loads. Hence, opamps with large output stage should be employed in order to avoid large power consumption.