IC Design of Integrated CMOS Filters

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Overview

This project presents a transconductor - C filter for the Ultra-Wide Band (UWB) system, which is

- Low noise (9.77 nVrms/Hz1/2),
- high dynamic range (69dB),
- and, less power consumption (16.4mW).

This is because Nauta’s transconductor topology is used to form an integrator, which has

- constant transconductance (5% relative transconductance for 0.8Vpp, Vdd = 1.8V, and Vss = 0V),
- non-domain pole is located at several ten giga-hertz,
- and the quality factor and the transconductance are tunable by changing the biasing voltage.

Objective

The aim of this project is to design and simulate an active filter such as an intermediate frequency (IF) channel-select filter in a direction-conversion UWB receiver.

The objective of this project focuses on optimizing:

- Linearity
- Dynamic range

on the condition that power consumption is limited.
Schematic & Layout

Schematic of the Designed Active Filter

Schematic for Nauta’s transconductor

The Layout of the Designed Filter
### Result

**Pre- Simulation Result**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Pre-Simulation Result</th>
<th>Post-Simulation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passband Gain</td>
<td>3.45 dB</td>
<td>2.79 dB</td>
</tr>
<tr>
<td>Passband Ripple</td>
<td>0.6 dB</td>
<td>0.74 dB</td>
</tr>
<tr>
<td>Lower -3 dB Frequency</td>
<td>89.5 KHz</td>
<td>4.89 MHz</td>
</tr>
<tr>
<td>Upper -3 dB Frequency $f_{up}$ (MHz)</td>
<td>261 MHz</td>
<td>260 MHz</td>
</tr>
<tr>
<td>Lower-Corner Channel Attenuation</td>
<td>78 dB</td>
<td>100 dB</td>
</tr>
<tr>
<td>Adjacent Channel Attenuation</td>
<td>22.75</td>
<td>22</td>
</tr>
<tr>
<td>Alternating Channel Attenuation</td>
<td>35.65</td>
<td>38</td>
</tr>
<tr>
<td>Source Resistor</td>
<td>0.95 KΩ</td>
<td>9.4 KΩ</td>
</tr>
<tr>
<td>Load Resistor</td>
<td>0.95 KΩ</td>
<td>9.4 KΩ</td>
</tr>
</tbody>
</table>

### Conclusion

In addition to the filter meeting all specifications, linearity and dynamic range were also enhanced.

- Linearity was enhanced by using Nauta’s trans-conductor. It cancels square terms in current equation by symmetric design.
- The dynamic range was enhanced because higher gm and higher capacitance in gyrators were used on the condition that gm/C ratio remained constant.