A CMOS Direct Sampling Mixer Using Switched Capacitor Filter Technique for Software-Defined Radio

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Outline

• Background
• Proposed circuit
• Measurement results
• Conclusion
Background

CDMA

GSM

Bluetooth

CDMA

GSM

Bluetooth

Single-standard

Multi-standards

Reconfigurable
Previous work

Multi-Tap Direct Sampling Mixer (MTDSM)

Problems of previous work

MTDSM’s issues

• Poor variability of filter characteristic
  – Low order of the filter

• Bad Noise Figure
  – Effect of flicker noise

• Not good for wideband
  – Pass-bands appear at multiples of LO
Proposed solution

Realize MTDSM using Switched Capacitor Filter (SCF) Technique

Features

• Filter characteristic is reconfigurable
• Promise higher-order filtering
• NF improvement (pass-band is shifted)
• Better for wideband (pass-band is shifted)
Proposed circuit

More reconfigurable
Could be higher-order

Passband shifted by $\pi$

Charge accumulated
+ Charge shared
NF improvement (pass-band shifted)

• Better NF (about 25dB)
• Better for wideband

Before shifted

After shifted

Reduce DC component
Measurement results

MTDSM for Digital Terrestrial Television (ISDB-T) 1-segment was fabricated.

RF: 400MHz nearby
BW: 430kHz
Measurement results (2)

<table>
<thead>
<tr>
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<th>0.18μm CMOS process</th>
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<tbody>
<tr>
<td>Technology</td>
<td>0.18μm CMOS process</td>
</tr>
<tr>
<td>Local Oscillator</td>
<td>800 MHz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>430 kHz</td>
</tr>
<tr>
<td>Power Gain @ 400.1 MHz input</td>
<td>12.4 dB</td>
</tr>
<tr>
<td>Attenuation @ 3MHz offset</td>
<td>27.3 dB</td>
</tr>
<tr>
<td>Supply Voltage VDD</td>
<td>1.8 V</td>
</tr>
<tr>
<td>LNTA + DSM core current</td>
<td>18 ~ 20 mA</td>
</tr>
<tr>
<td>Power consumption</td>
<td>32.4 ~ 36 mW</td>
</tr>
<tr>
<td>Chip area</td>
<td>1150μm x 750μm</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>Previous work</th>
<th>SCF</th>
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</thead>
<tbody>
<tr>
<td>Reconfigurability</td>
<td>Medium</td>
<td>Better</td>
</tr>
<tr>
<td>NF</td>
<td>Medium</td>
<td>Better</td>
</tr>
<tr>
<td>Gain</td>
<td>Bad</td>
<td>Better</td>
</tr>
<tr>
<td>Power</td>
<td>Better</td>
<td>Bad</td>
</tr>
<tr>
<td>Area</td>
<td>Medium</td>
<td>Medium</td>
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Conclusion

• A direct sampling mixer using switched capacitor filter technique is proposed.

• It improves the reconfigurability while not increasing the power, area so much.

SCF’s Features

• Easier to reconfigure
• Promise higher-order filtering
• NF improvement (pass-band shifted)
• Better for wideband (pass-band is shifted)
Thank you for your interest!

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