LIST OF FIGURES

Fig 2.1 Schematic symbol of generalized (a) three port current conveyor
(b) first kind four port current conveyor
(c) second kind four port current conveyor

Fig 2.2 Simplified representation of CCII

Fig 2.3 Nullator–norator representation of a CCII

Fig 2.4 Non ideal CCII with its parasitic impedances and voltage and current transfers

Fig 2.5(a) Translinear implementation of CCII+
Fig 2.5(b) Translinear implementation of CCII-
Fig 2.5(c) Translinear implementation of MOCCII

Fig. 2.6 Circuit representation of CCCII

Fig. 2.7 Non ideal CCCII with its parasitic impedances and voltage and current transfers

Fig. 2.8(a) Translinear implementation of CCCII+
Fig. 2.8(b) Translinear implementation of CCCII-

Fig. 2.9 Translinear implementation of MO-CCCII

Fig. 2.10 Inter reciprocal networks N₁ and N₂

Fig. 2.11 Some electrical elements and their corresponding adjoint elements

Fig. 2.12 Op amp based network

Fig. 2.13 Nullator-norator representation and generation of CCII based networks
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.14(a)</td>
<td>Damped voltage integrator with op amp</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>(b) current integrator with CCII</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>(c) voltage integrator with CCII</td>
<td>30</td>
</tr>
<tr>
<td>3.1</td>
<td>Proposed multiple loop feedback current mode</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>biquadratic filter structure</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Structure-1 generated from proposed topology</td>
<td>41</td>
</tr>
<tr>
<td>3.3</td>
<td>Structure-1 topology A</td>
<td>41</td>
</tr>
<tr>
<td>3.4</td>
<td>Proposed filter structure including parasitics</td>
<td>48</td>
</tr>
<tr>
<td>3.5</td>
<td>Dependence of frequency on capacitor (C) for band pass filter</td>
<td>52</td>
</tr>
<tr>
<td>3.6</td>
<td>Simulated (a) low pass, band pass and high pass responses</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>(b) orthogonal tunability of notch responses</td>
<td></td>
</tr>
<tr>
<td>3.7</td>
<td>Dependence of total harmonic distortion (%THD) on input signal</td>
<td>53</td>
</tr>
<tr>
<td>3.8</td>
<td>All pass filter with single CCII-</td>
<td>56</td>
</tr>
<tr>
<td>3.9</td>
<td>All pass filter with single CCCII-</td>
<td>57</td>
</tr>
<tr>
<td>3.10</td>
<td>Gain and phase plot of APF of Fig. 3.13 at $f_0 = 1$ kHz</td>
<td>60</td>
</tr>
<tr>
<td>3.11</td>
<td>CCII- based generic configurations for all pass filter</td>
<td>61</td>
</tr>
<tr>
<td>3.12</td>
<td>CCCII- based generic configurations for all pass filter</td>
<td>61</td>
</tr>
<tr>
<td>3.13</td>
<td>Phase and gain plots of selected circuits from Table 3.3</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>(a) circuit 5, (b) circuit 6, (c) circuit 7, (d) circuit 8</td>
<td></td>
</tr>
<tr>
<td>3.14</td>
<td>Phase response variation for circuit 5 with $R_2$ (Table 3.3)</td>
<td>64</td>
</tr>
<tr>
<td>3.15</td>
<td>Proposed CCCII+ based channel select filter</td>
<td>68</td>
</tr>
<tr>
<td>3.16</td>
<td>Simulation results showing wireless standard selection</td>
<td>71</td>
</tr>
</tbody>
</table>
Fig 3.17 Output spectrum of filter under two tone test 71
Fig 3.18 Op amp based Tow Thomas biquadratic filter 74
Fig 3.19 Various steps for generating CCII based structure 74
Fig 3.20 CCCII- based Tow Thomas filter 74
Fig 3.21 Proposed Tow Thomas filter structure including parasitics 77
Fig 3.22 Gain and phase responses of notch filter 81
Fig. 4.1 MOCCII based current mode SITO filter 85
Fig. 4.2(a) Low pass, band pass and high pass responses of the proposed filter 90
   (b) Orthogonal tunability of band pass responses
Fig. 4.3 Op amp based Tow Thomas Circuit 92
Fig. 4.4 Various steps involved in generating CCII based Tow Thomas Filter 93
Fig. 4.5 CCII based Tow Thomas filter 93
Fig. 4.6 CCCII based Tow Thomas filter 94
Fig. 4.7 Frequency response of the voltage mode Tow Thomas circuit 97
Fig. 4.8 (a) Simulated response for band pass filter gain tunability 98
   (b) Simulated response for low pass filter gain tunability
Fig. 5.1 Proposed current mode MISO biquad 102
Fig. 5.2 Low pass, Band pass and High pass responses for circuit 1 (Table 5.1) 108
Fig. 5.3 Gain and phase responses of the notch filter for circuit 1 (Table 5.1) 108
Fig. 5.4 Orthogonal tunability of band pass response 109
Fig. 5.5 Dependence of total harmonic distortion (%THD) on input signal 109
Fig. 5.6 CCII+ based voltage mode MISO filter 113
Fig. 5.7 CCCII+ based voltage mode MISO filter 115
Fig. 5.8 Simulated and Experimental frequency responses for CCII+ based filter
(a) low pass and high pass (b) band pass and notch

Fig. 5.9 Variation of $Q_0$ keeping $\omega_0$ constant ($= 636.94$ kHz) for band pass output

Fig. 5.10 Variation of $\omega_0$ keeping $Q_0$ constant ($=1.0$) for band pass output

Fig. 5.11 MISO mixed mode filter configuration based on
plus type current conveyors

Fig. 5.12 Experimental and Simulated frequency response for
(a) low pass and high pass (b) band pass and notch (c) all pass filters

Fig. 6.1 Proposed current mode multiple-input multiple-output biquad

Fig. 6.2 Orthogonal tunability of band pass response

Fig. 6.3 Orthogonal tunability of notch response

Fig. 6.4 Dependence of total harmonic distortion (%THD) on input signal

Fig. 6.5 Proposed DOCCII based MIMO voltage mode filter

Fig. 6.6 Simulated and theoretical low pass and band pass responses
of the proposed filter at $V_{out1}$

Fig 6.7 Orthogonal tunability of (a) $\omega_0$, (b) $Q_0$ and (c) gain
of the proposed filter at $V_{out2}$

Fig. 6.8 Proposed mixed mode filter

Fig. 6.9 Simulated and theoretical responses of the proposed mixed mode filter

Fig. 6.10 (a) Orthogonal tunability of $Q_0$ and $\omega_0$ with fixed $f_0$
(b) Orthogonal tunability of $\omega_0$ and $Q_0$ with fixed $Q_0$

Fig. 6.11 Gain/Quality factor tuning with fixed $\omega_0$ for band pass filter
under CM operation
Fig. 6.12 Proposed mixed mode circuit using DOCCCIIs 155

Fig. 6.13 Proposed mixed mode universal filter using DOCCCII and MOCCCII 156

Fig. 6.14 Proposed CCCII based mixed mode filter structure including parasitics 162

Fig. 6.15 Dependence of frequency on capacitor (C) values for CM filter of Fig. 6.13 166

Fig. 6.16 (a) Frequency Response of current mode filter 167

(b) Orthogonal tunability of $Q_0$ and $\omega_0$

Fig. 6.18 Variation of total harmonic distortion (%THD) 168

with input signal amplitude