Feedback Amplifier Analysis using Two-port Network Theory

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th>Closed Loop Parameters</th>
<th>Open Loop Parameters</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>$R_{IN}$</td>
<td>$R_{OUT}$</td>
<td>$A$</td>
</tr>
<tr>
<td>$A_v = \frac{v_{out}}{v_{in}} = \frac{A}{1+\alpha}$</td>
<td>$R_{IO} \cdot (1+\alpha)$</td>
<td>$\frac{R_{LO}}{1+\alpha}$</td>
<td>$-\frac{h_{21}^\beta}{R_{IO} \cdot R_{LO}}$</td>
</tr>
<tr>
<td>$A_f = \frac{i_{out}}{i_{in}} = \frac{A}{1+\alpha}$</td>
<td>$R_{IO} \cdot (1+\alpha)$</td>
<td>$\frac{g_{12}^\beta}{R_{LO}}$</td>
<td>$\frac{1}{R_s}$</td>
</tr>
<tr>
<td>$A_{IC} = \frac{i_{out}}{v_{in}} = \frac{A}{1+\alpha}$</td>
<td>$R_{IO} \cdot (1+\alpha)$</td>
<td>$\frac{z_{12}^\beta}{R_{LO}}$</td>
<td>$\frac{1}{R_s}$</td>
</tr>
<tr>
<td>$A_{ib} = \frac{v_{out}}{i_{in}} = \frac{A}{1+\alpha}$</td>
<td>$R_{IO} \cdot (1+\alpha)$</td>
<td>$-\frac{y_{21}^\alpha \cdot R_{IO} \cdot R_{LO}}{1+\alpha}$</td>
<td>$\frac{1}{R_s}$</td>
</tr>
</tbody>
</table>

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**Determining Two-Port Parameters.**

<table>
<thead>
<tr>
<th>2-port Description</th>
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<th>11</th>
<th>12</th>
<th>21</th>
<th>22</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h$-parameters</td>
<td>$v_i = h_{11} \cdot i_i + h_{12} \cdot v_2$</td>
<td>$h_{11} = \frac{v_i}{i_i}$ &amp; $h_{12} = \frac{v_i}{v_2}$</td>
<td>$h_{21} = \frac{i_2}{i_2}$ &amp; $h_{22} = \frac{i_2}{v_1}$</td>
<td>$v_1$ &amp; $i_2$</td>
<td></td>
</tr>
<tr>
<td>$g$-parameters</td>
<td>$i_1 = g_{11} \cdot v_1 + g_{12} \cdot i_2$</td>
<td>$g_{11} = \frac{i_1}{v_1}$ &amp; $g_{12} = \frac{i_1}{i_2}$</td>
<td>$g_{21} = \frac{v_2}{v_1}$ &amp; $g_{22} = \frac{v_2}{i_2}$</td>
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<td>$z$-parameters</td>
<td>$v_i = z_{11} \cdot i_i + z_{12} \cdot v_2$</td>
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<td>$y$-parameters</td>
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$v_i=0$ means short the ports of two-port network on the i side. $i_i=0$ means open circuit the ports of two-port network on the i side.

Suat Ay (SP2008)