

# **Structured Electronic Design**

Balancing of two-ports

*Anton J.M. Montagne*

# Nonlinear and complementary two-ports

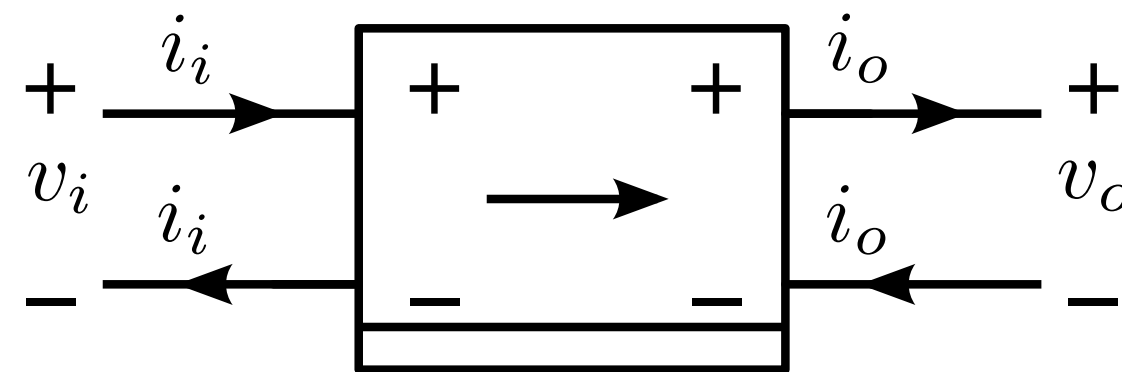
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Six possible notations

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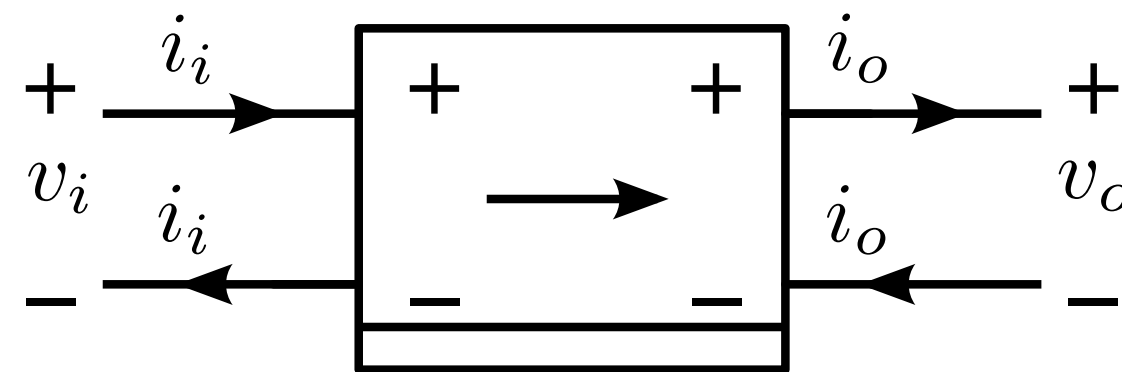
Anti-causal (T1) notation:



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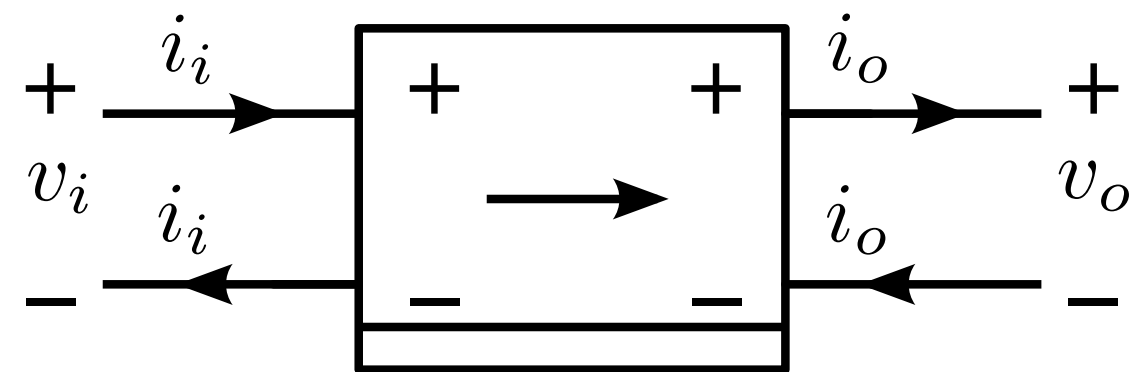


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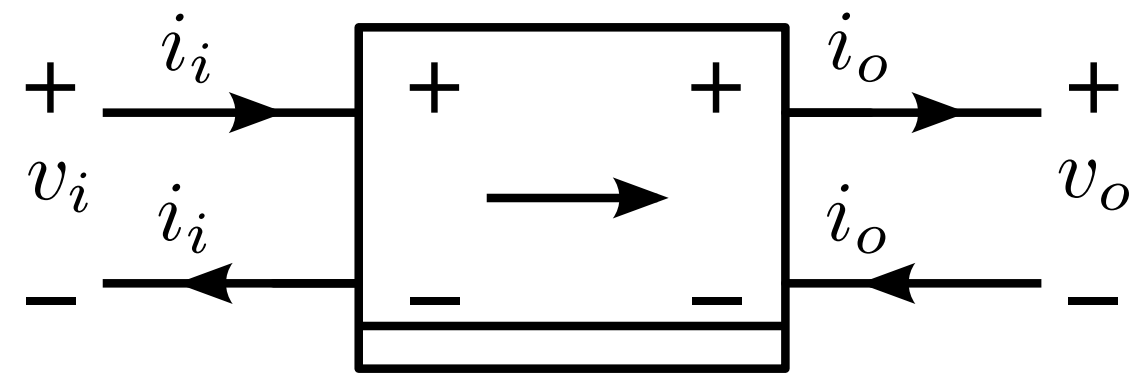
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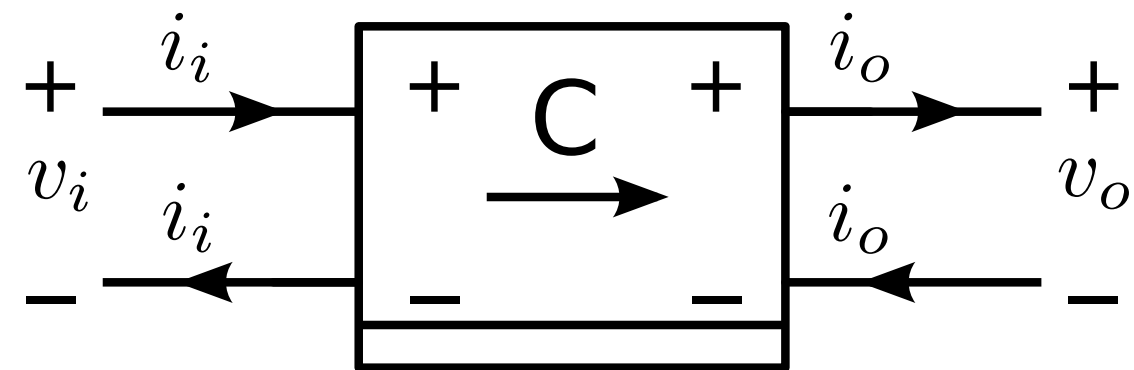
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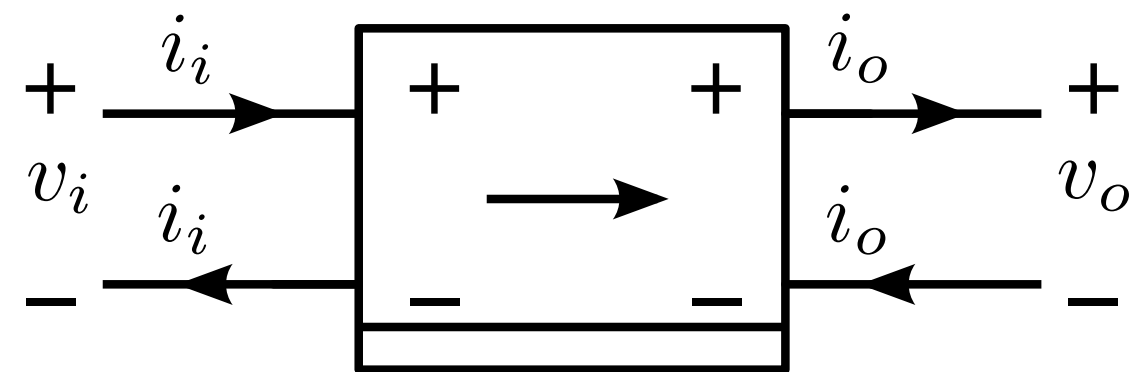
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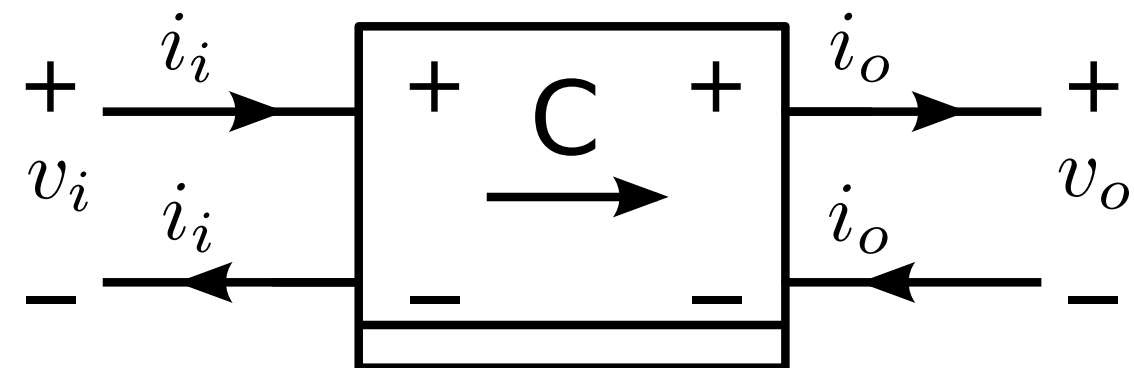
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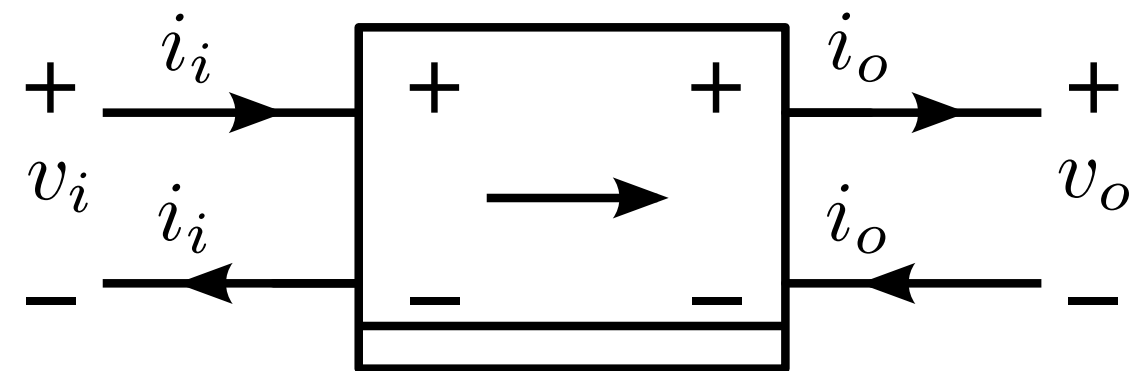
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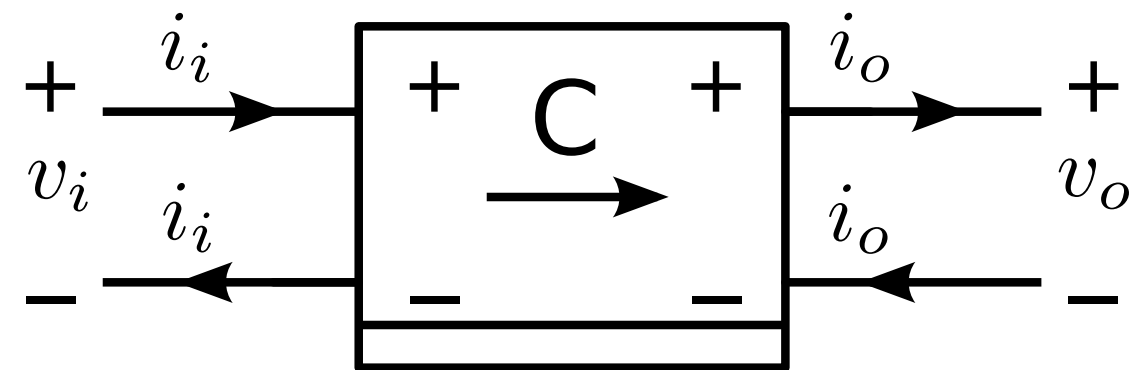
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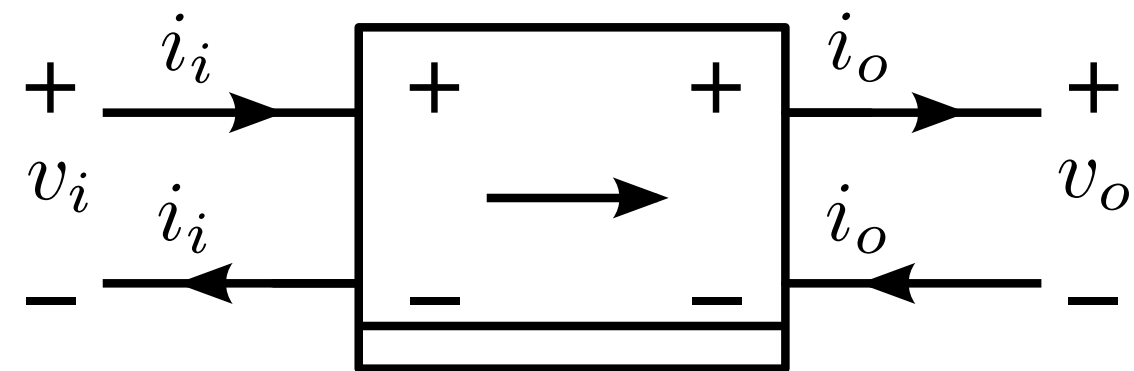
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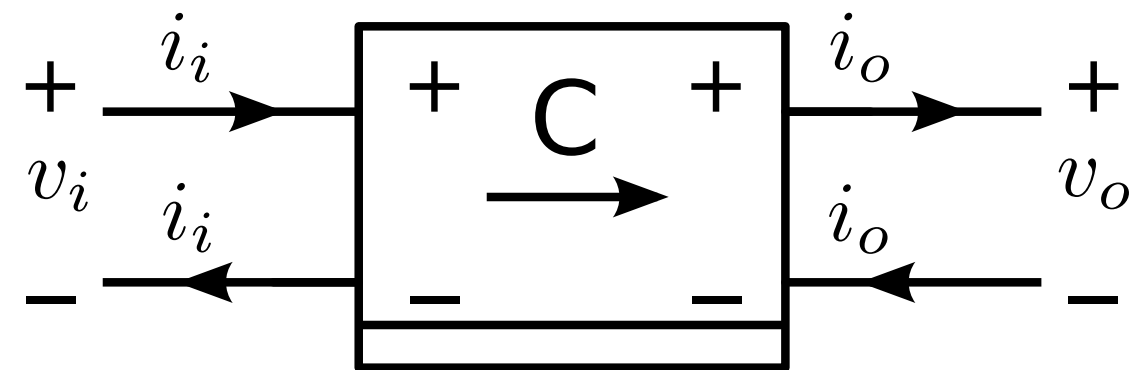
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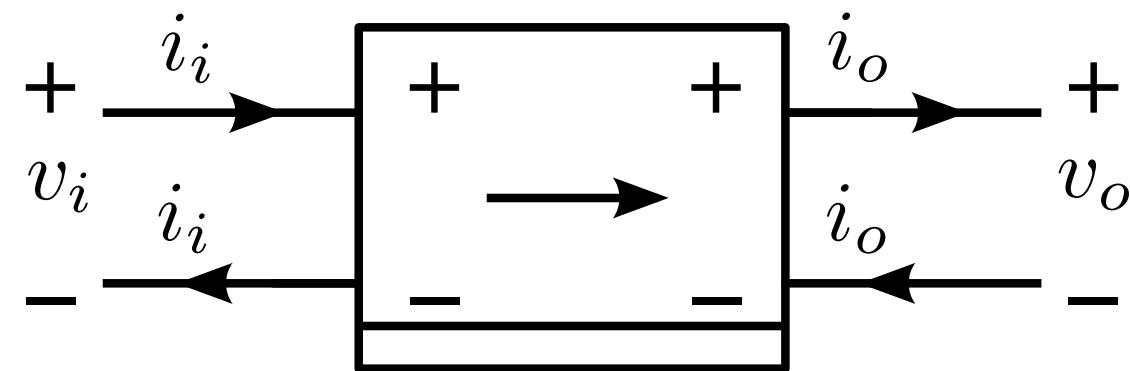
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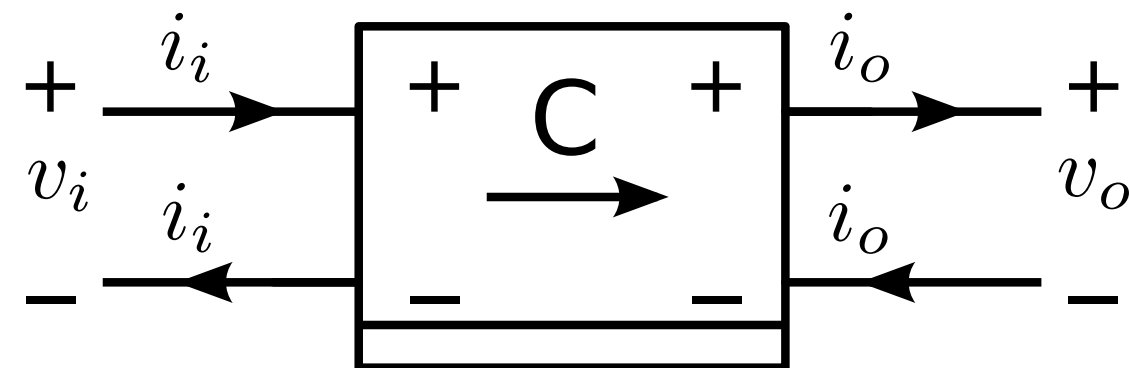


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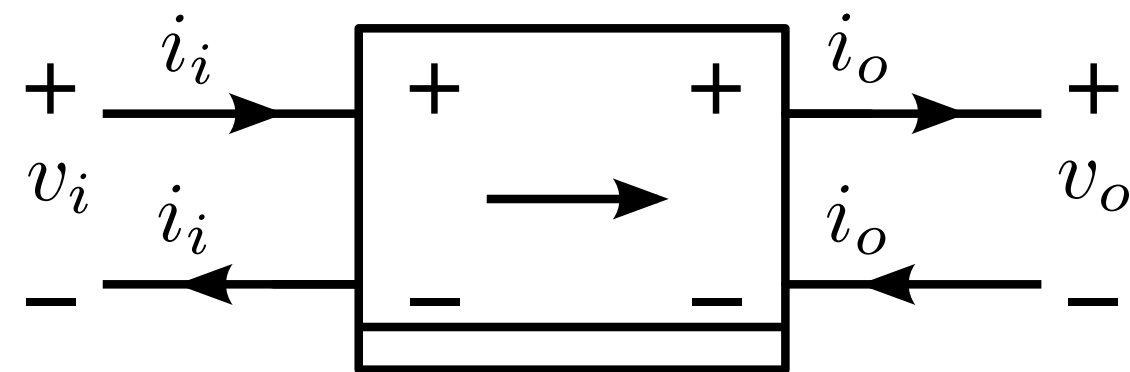
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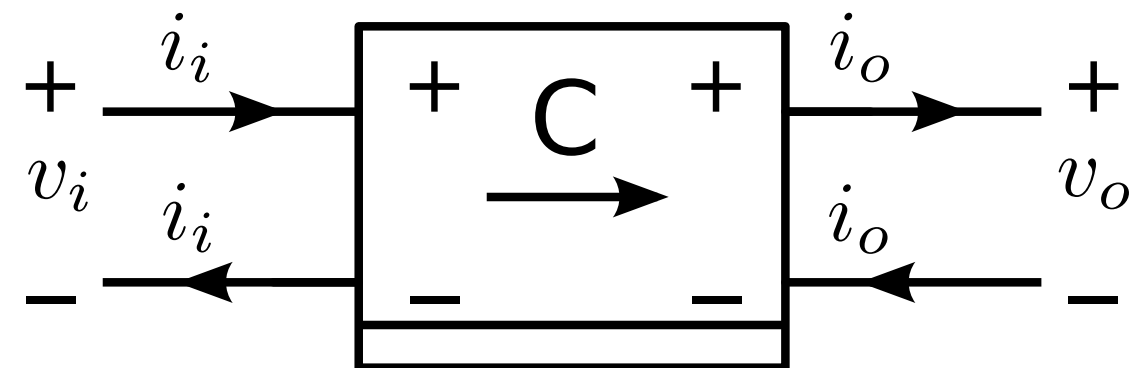
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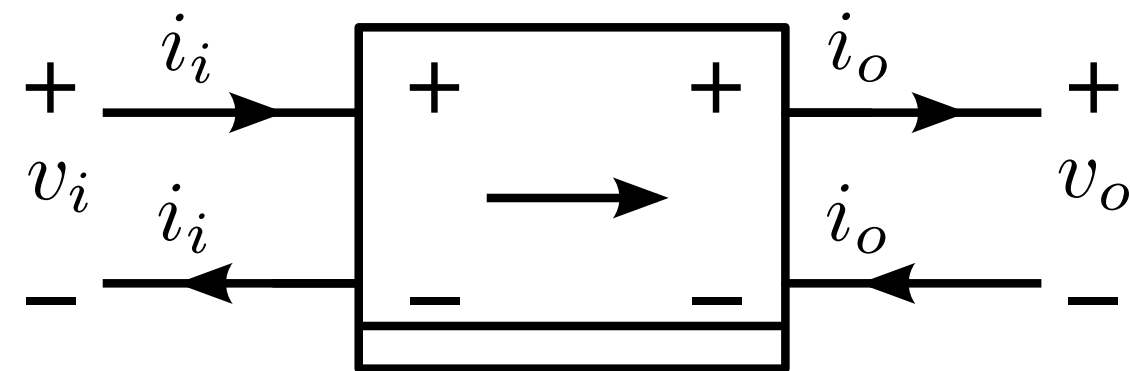
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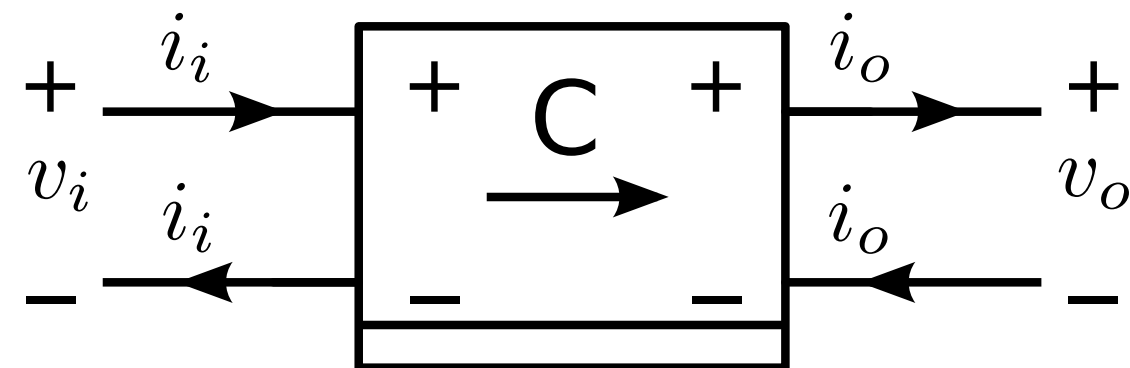
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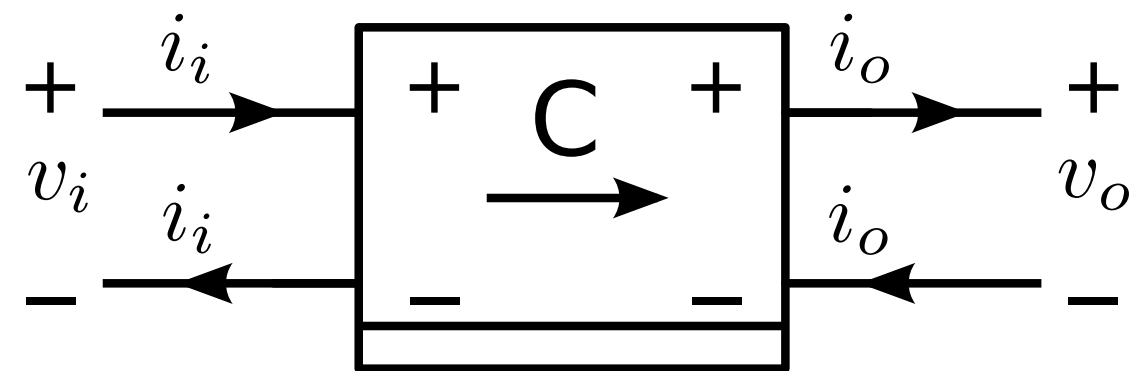
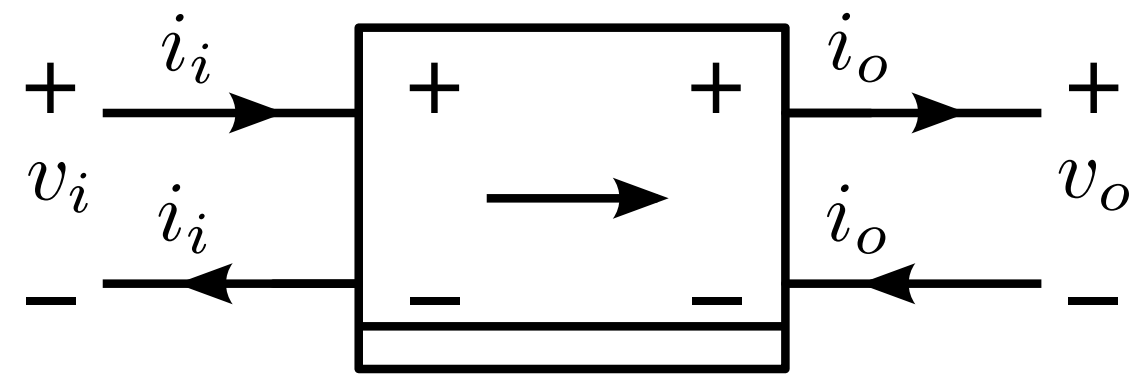
$$g_2(v_o, i_o) = -f_2(-v_o, -i_o)$$



$$v_i = g_1(v_o, i_o)$$

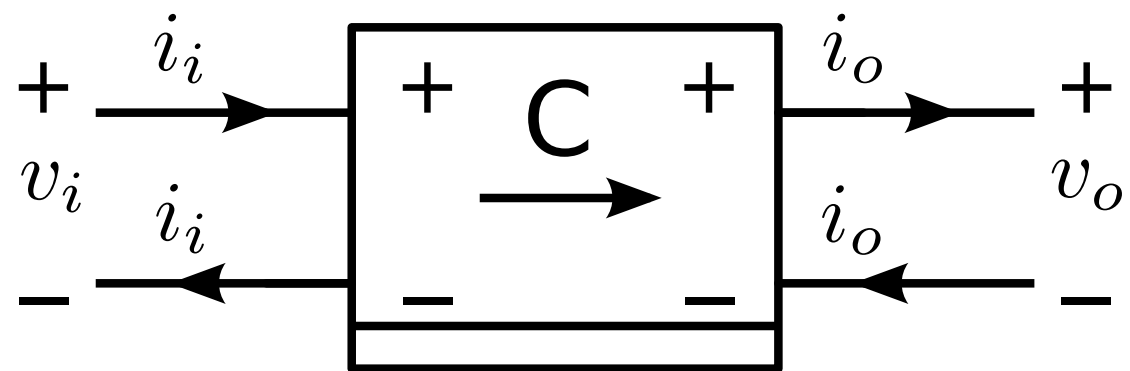
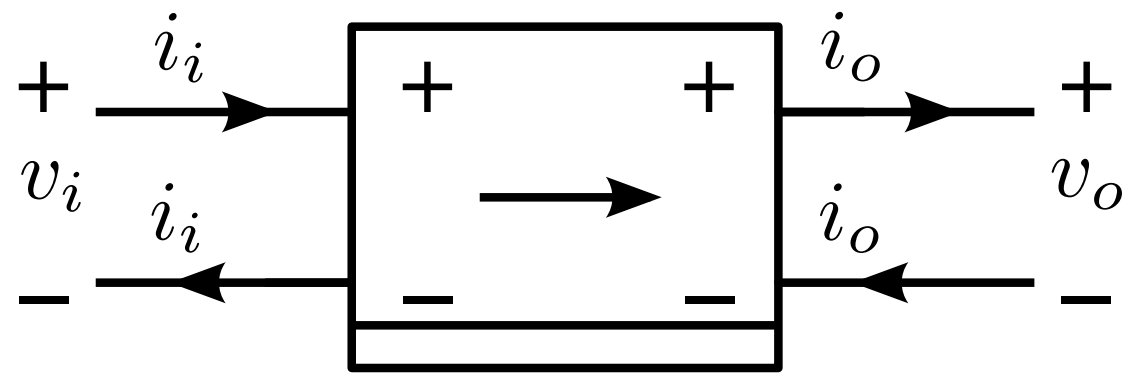
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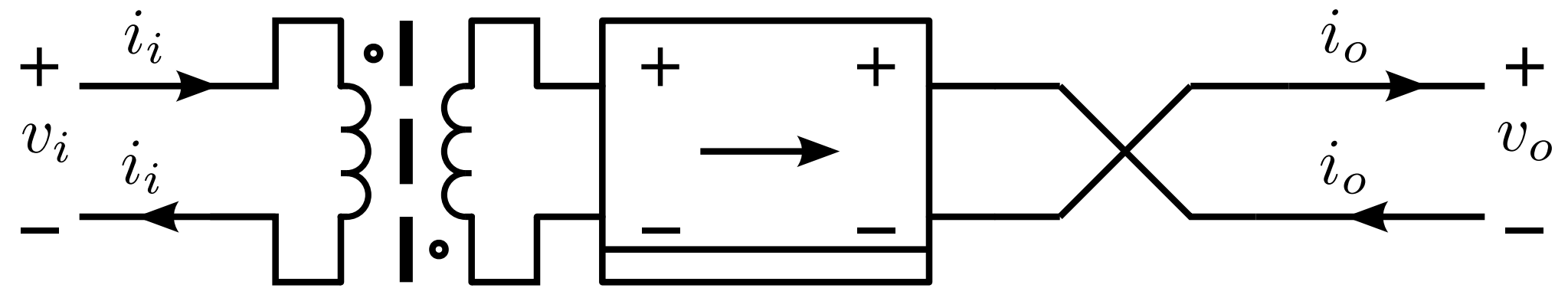
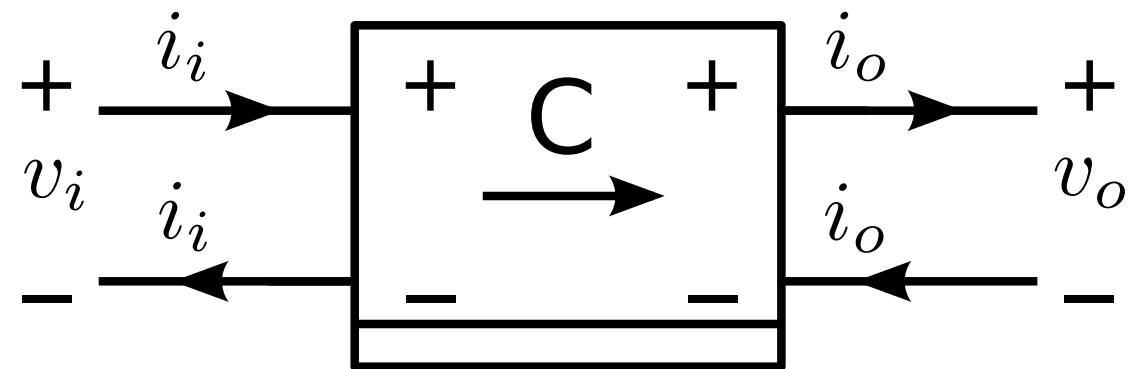
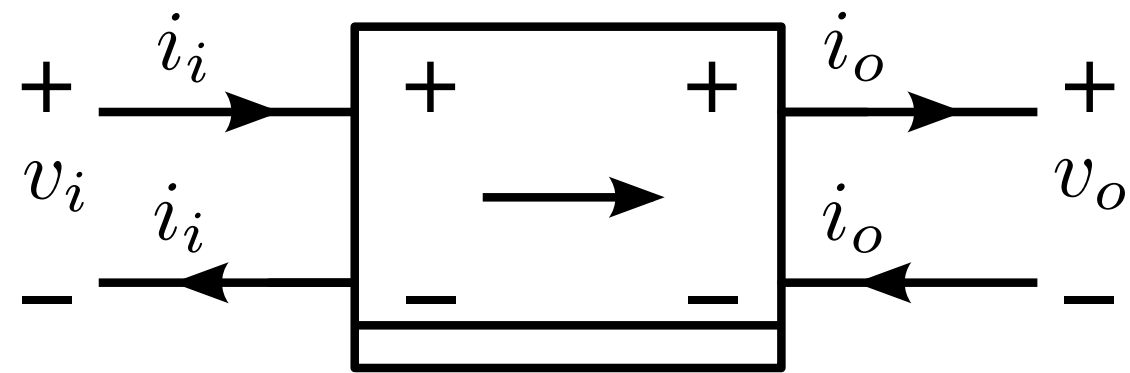
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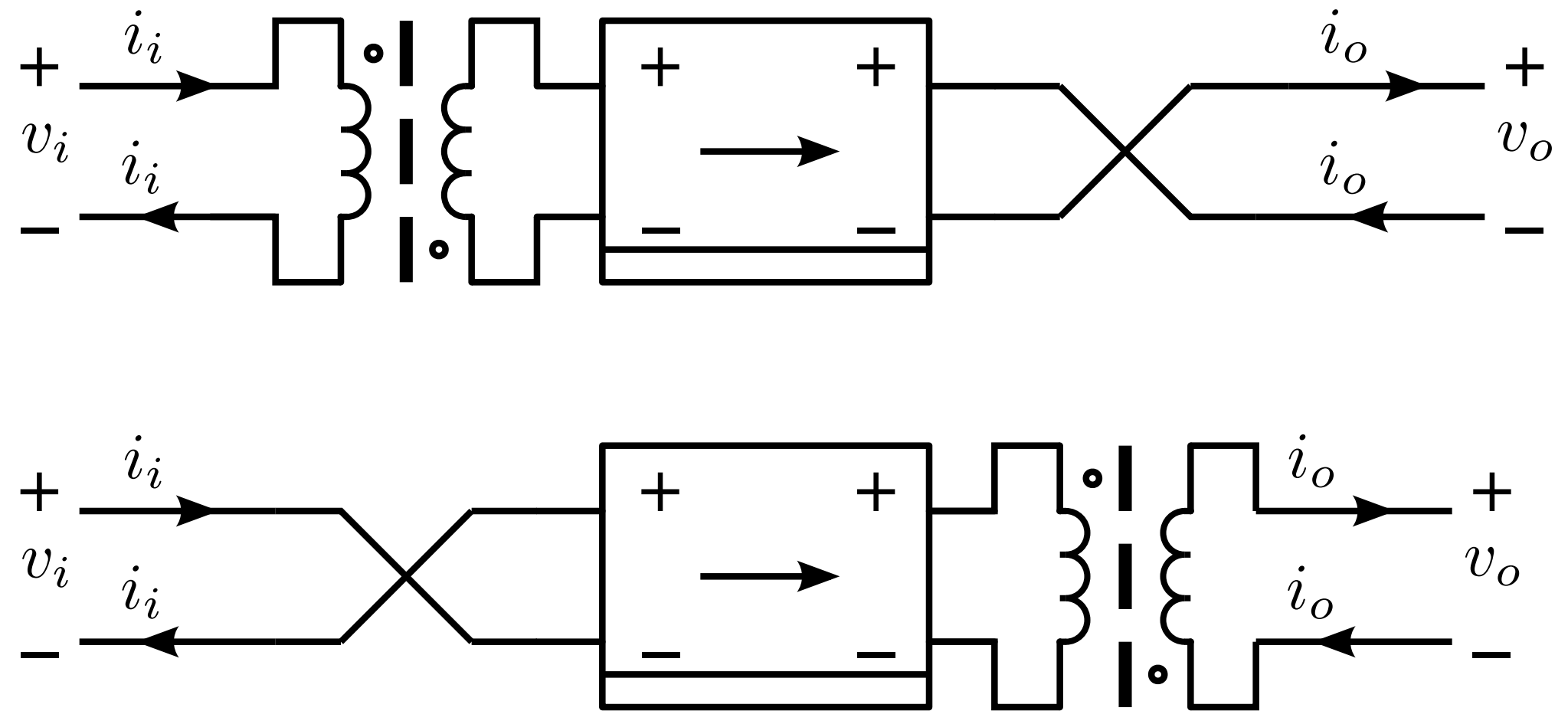
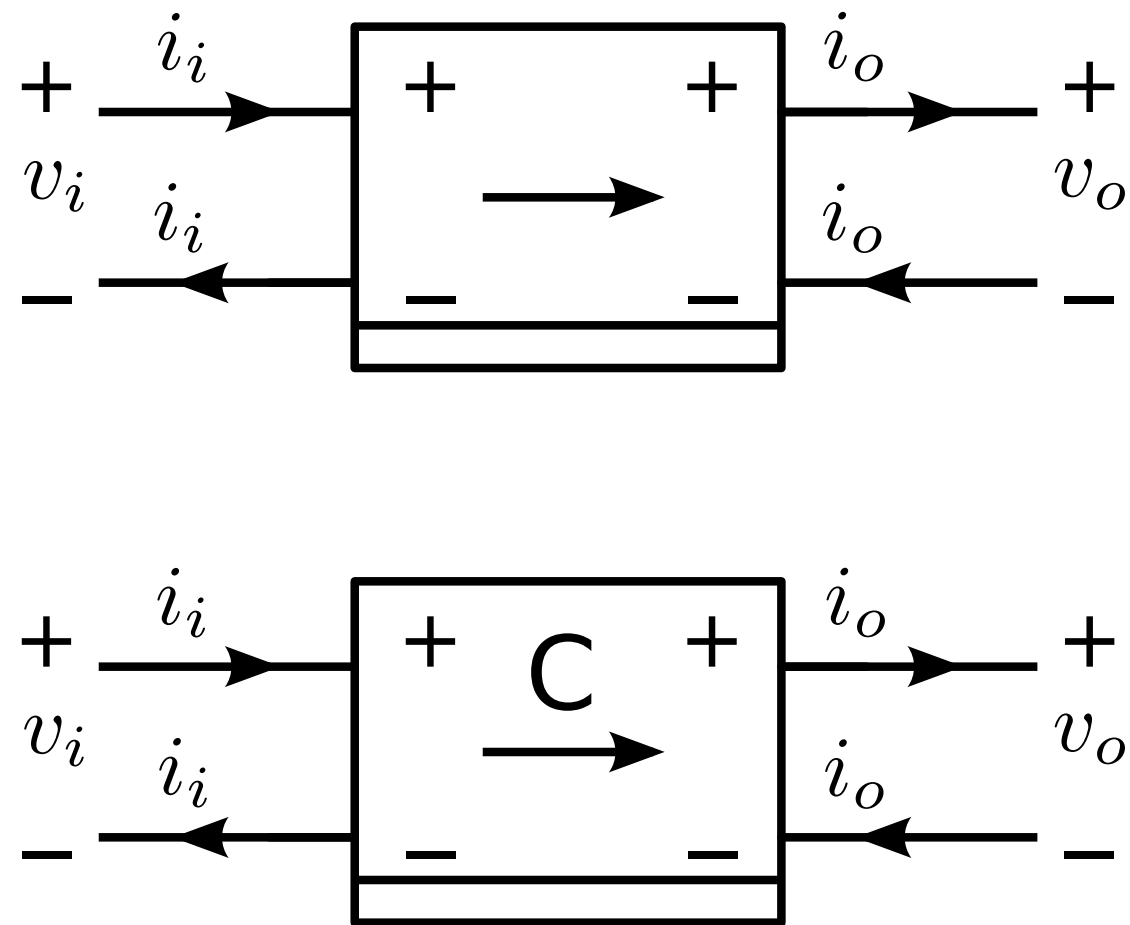
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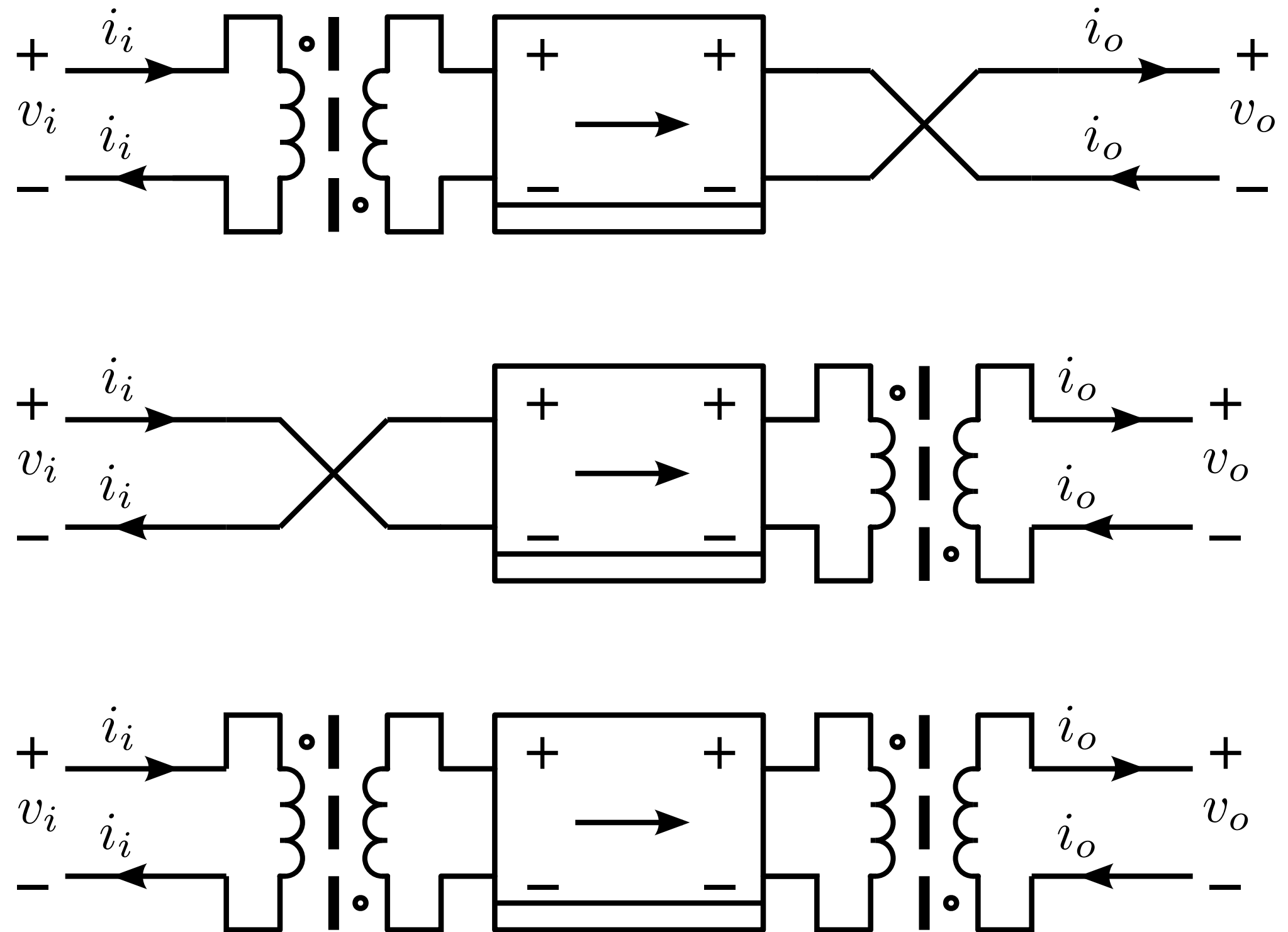
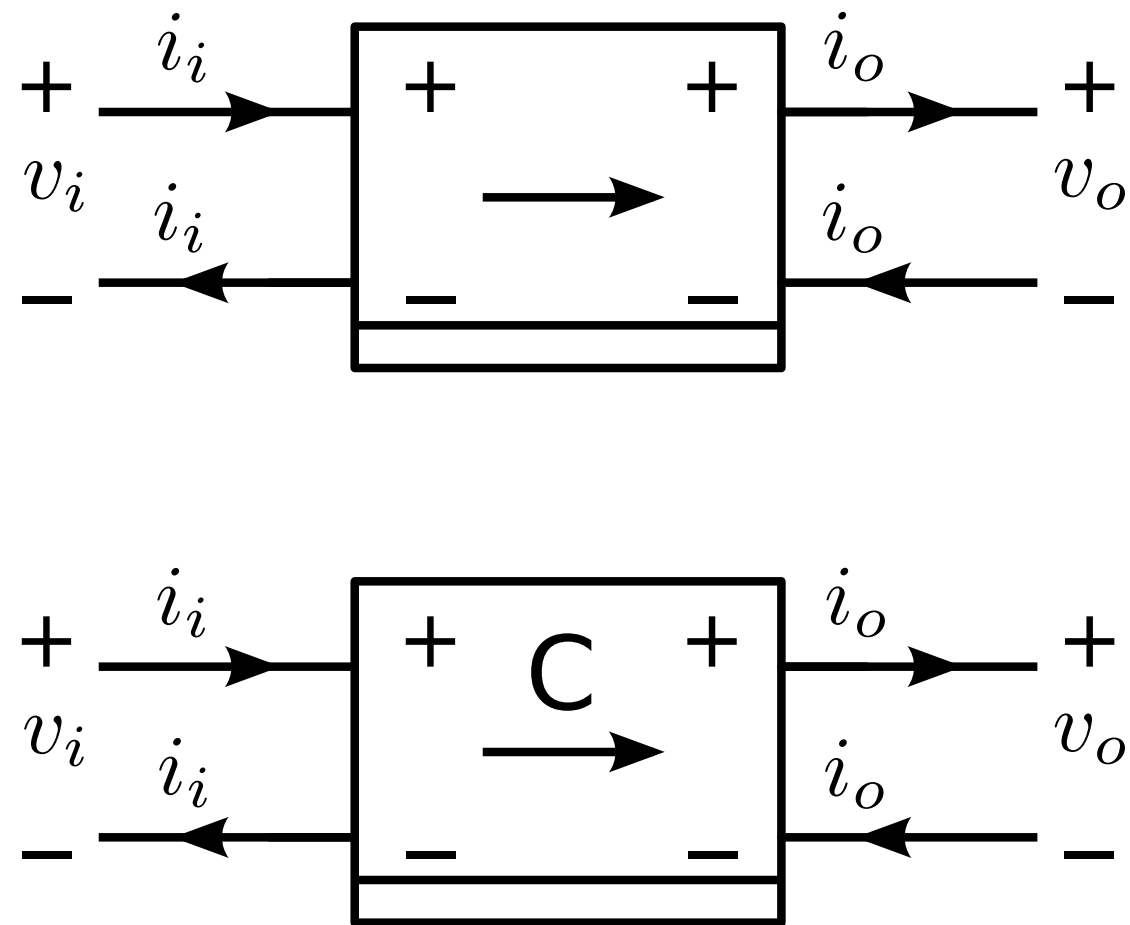
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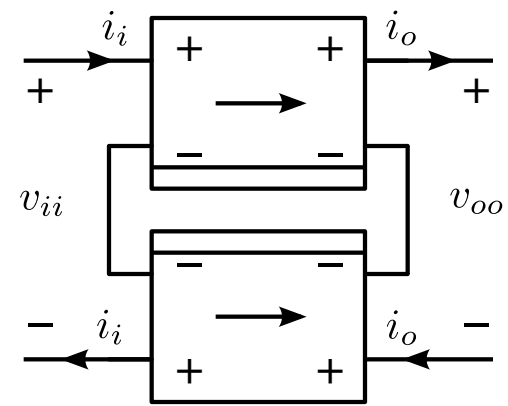
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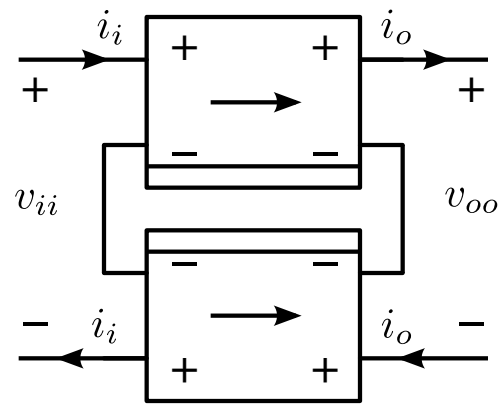
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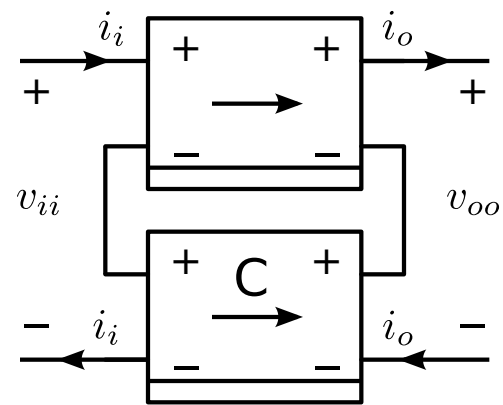


anti-series

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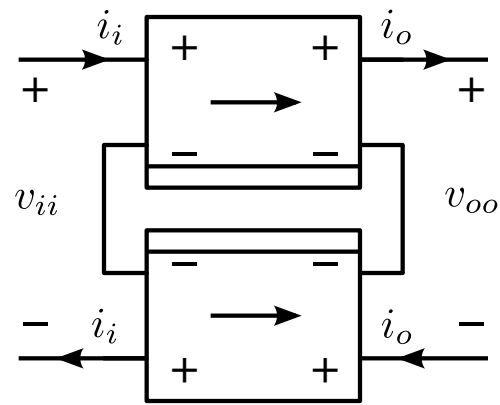


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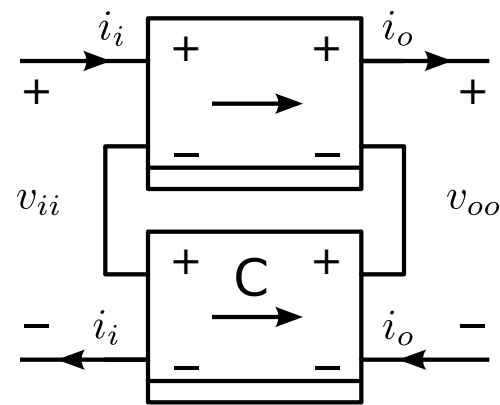


complementary-series

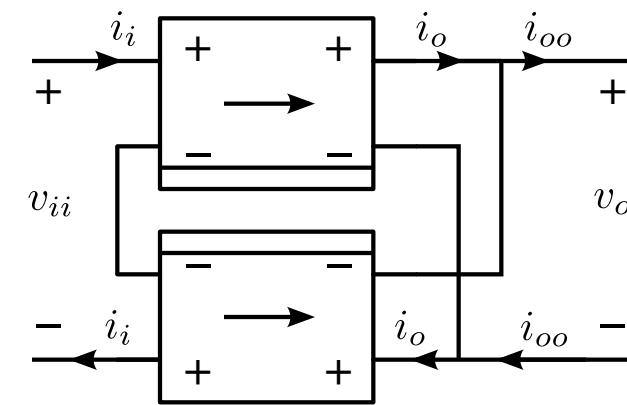
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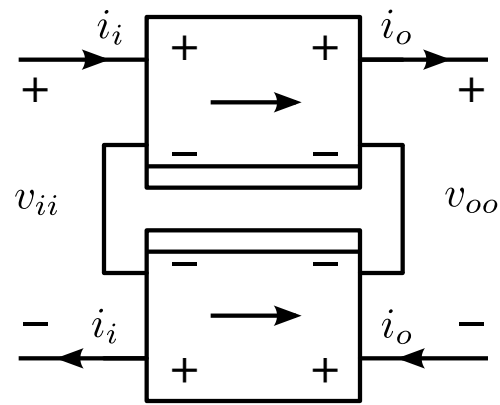


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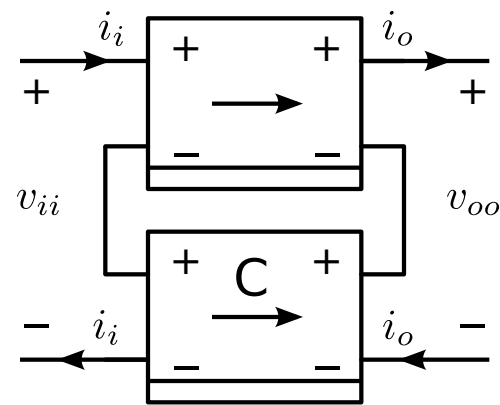


anti-series in  
anti-parallel out

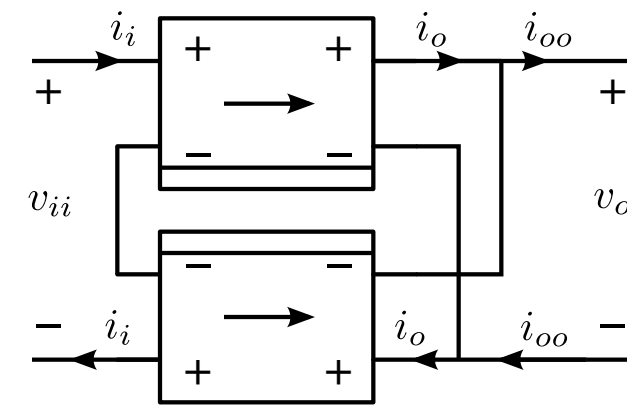
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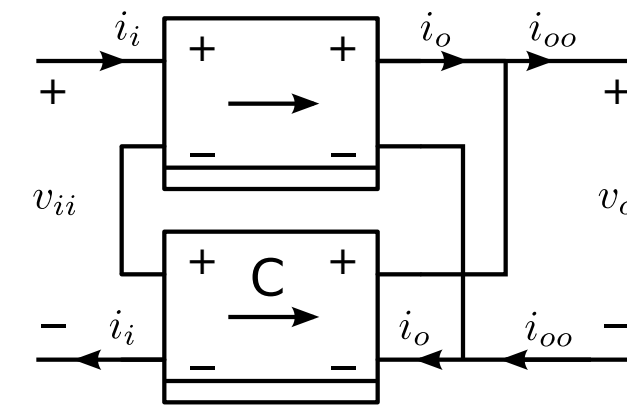
anti-series



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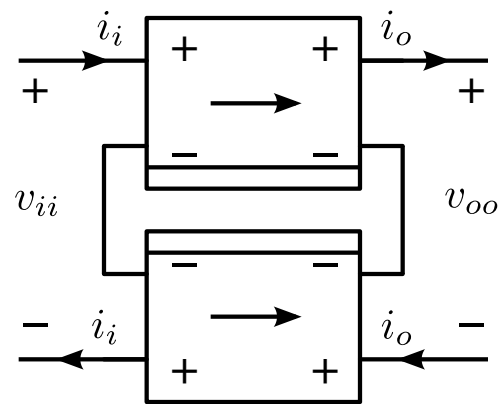


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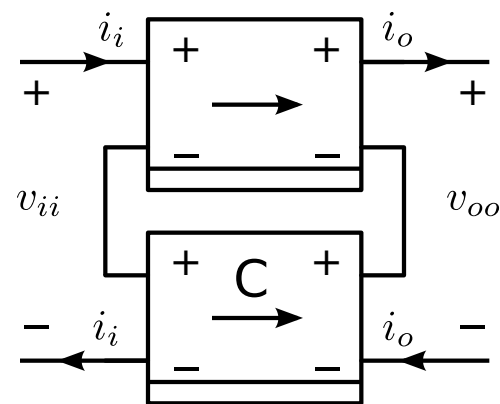


complementary-series in  
complementary-parallel out

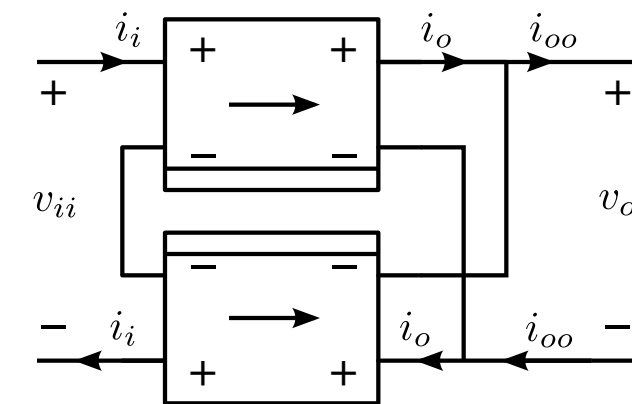
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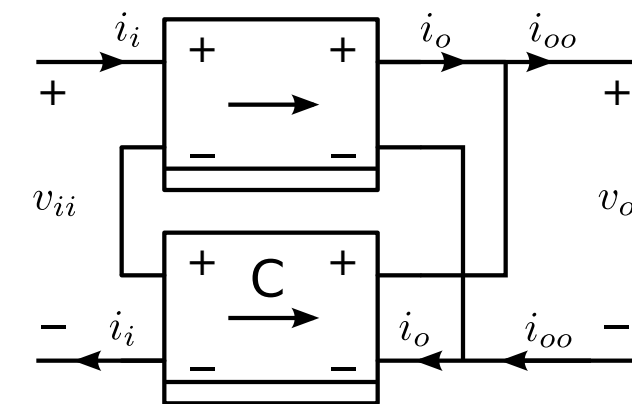
anti-series



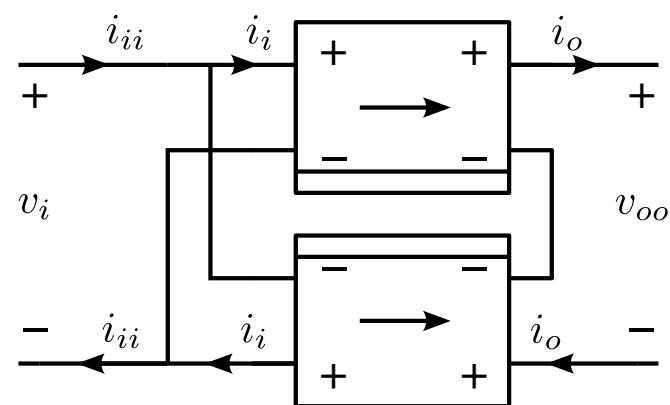
complementary-series



anti-series in  
anti-parallel out



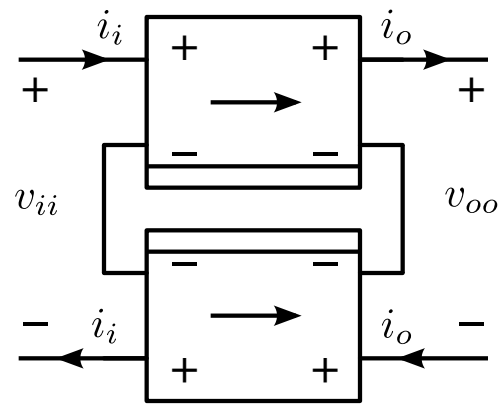
complementary-series in  
complementary-parallel out



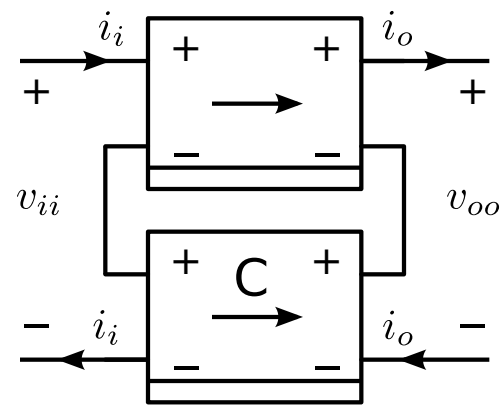
anti-parallel in  
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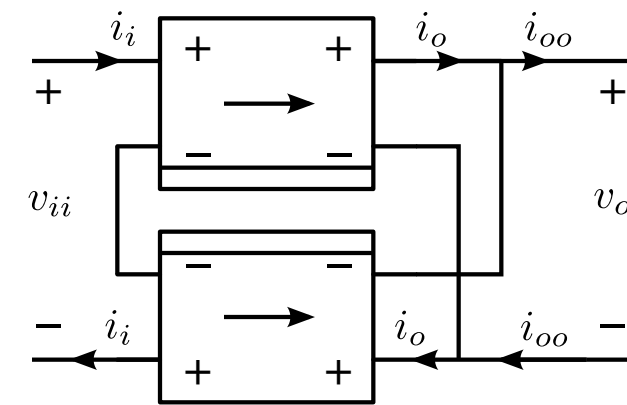
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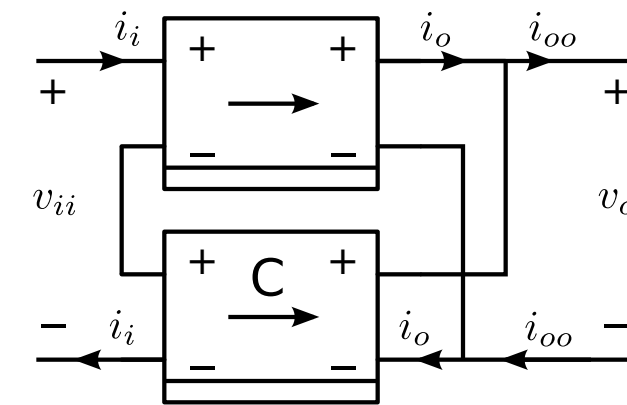
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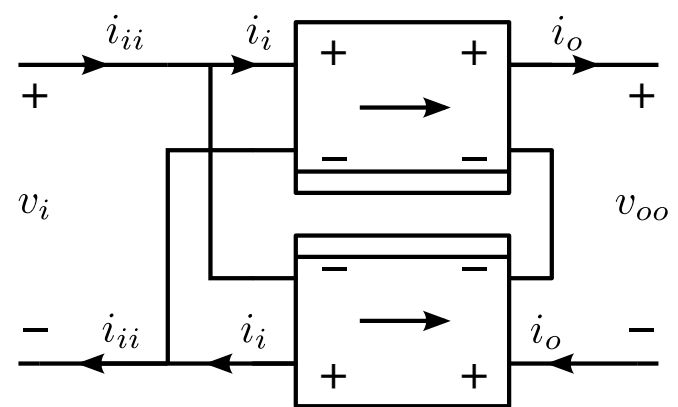
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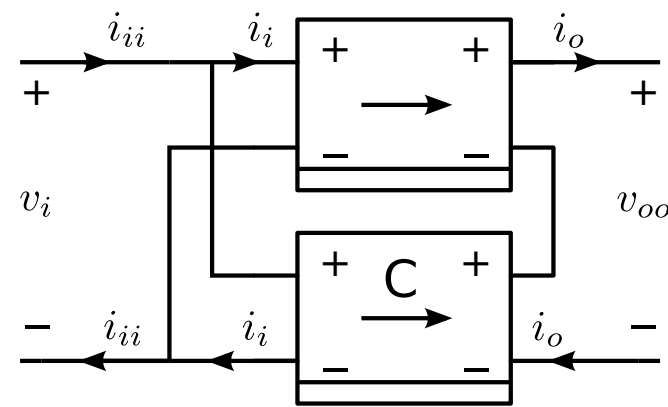
anti-series in  
anti-parallel out



complementary-series in  
complementary-parallel out

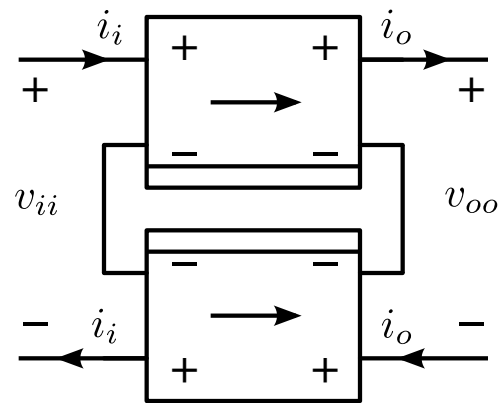


anti-parallel in  
anti-series out

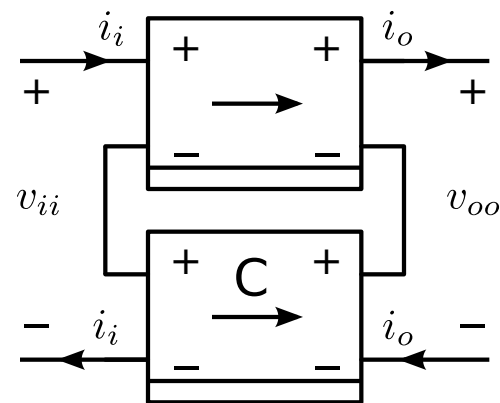


complementary-parallel in  
complementary-series out

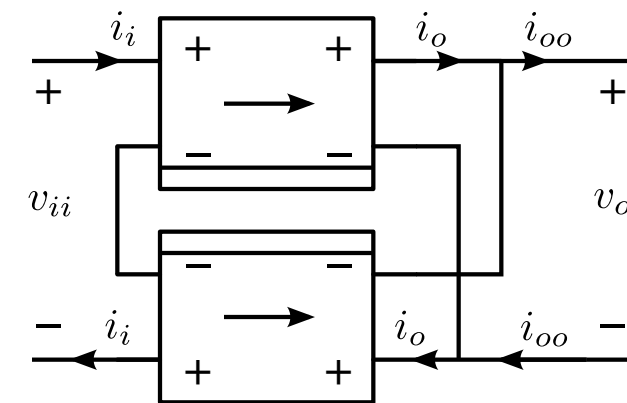
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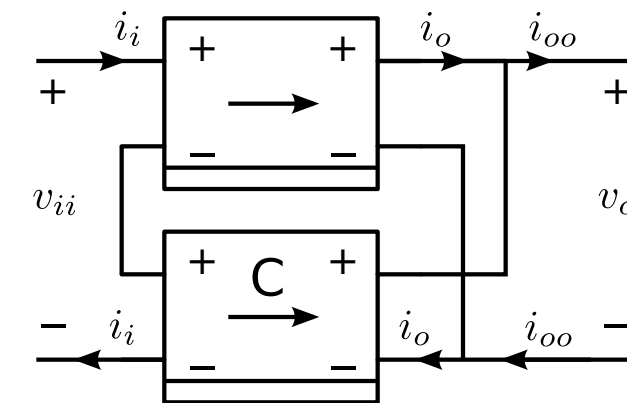
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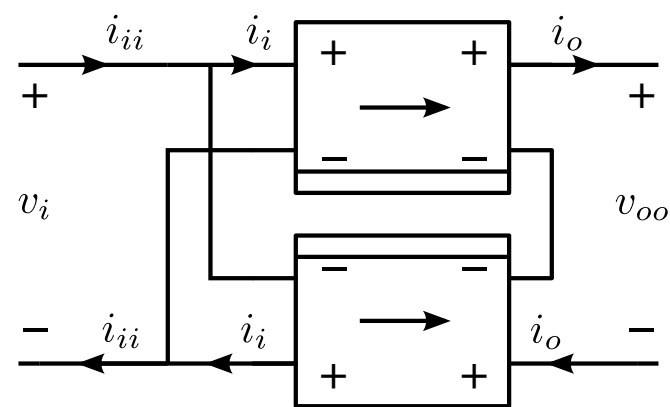
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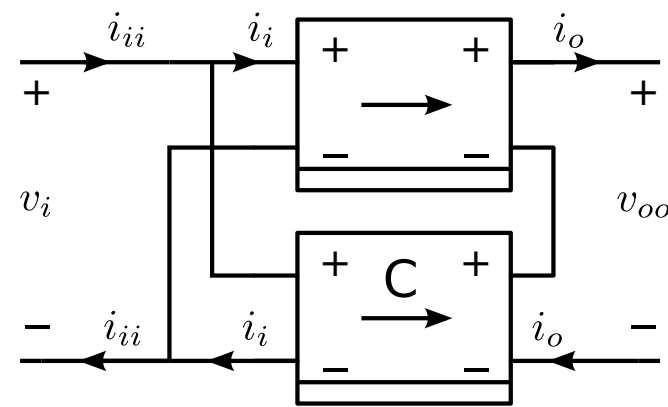
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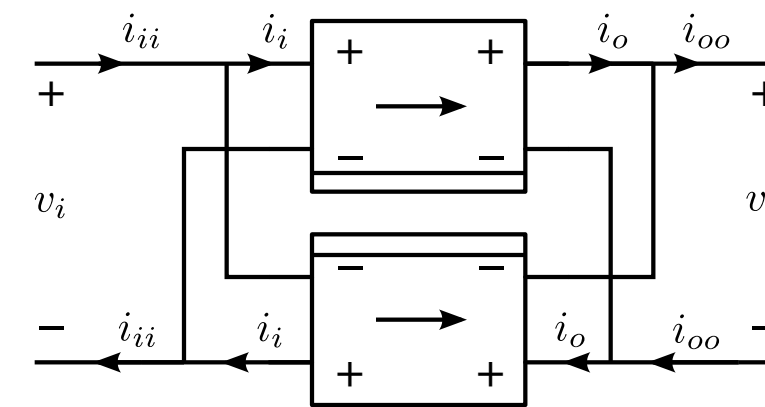
complementary-series in  
complementary-parallel out



anti-parallel in  
anti-series out

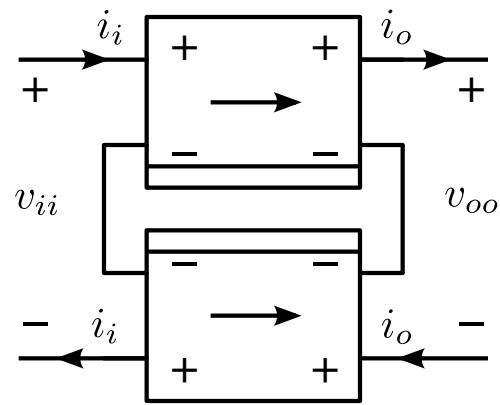


complementary-parallel in  
complementary-series out

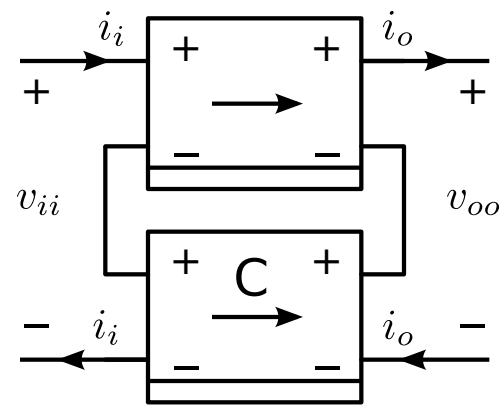


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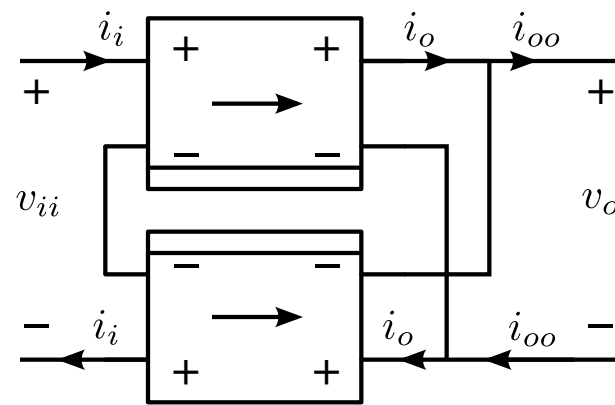
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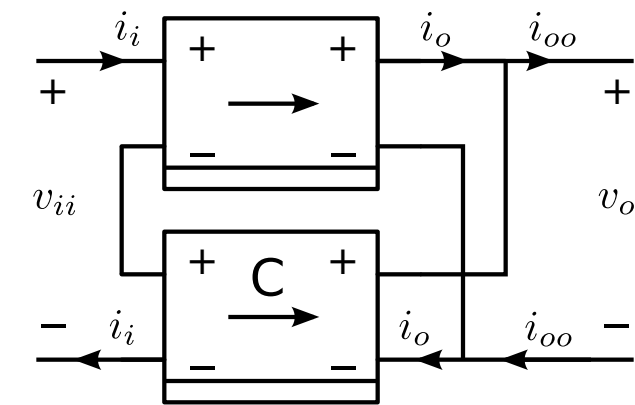
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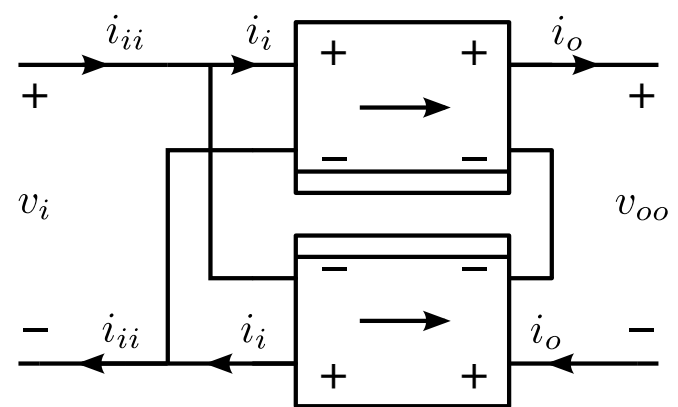
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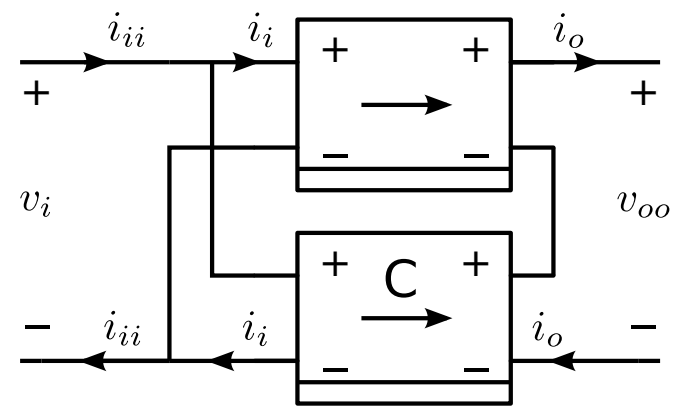
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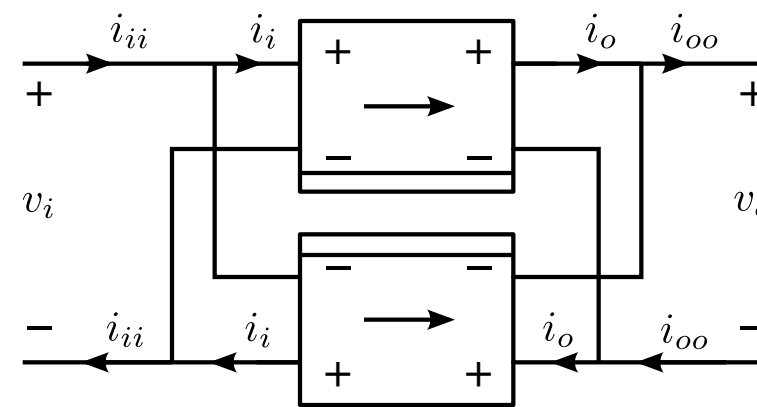
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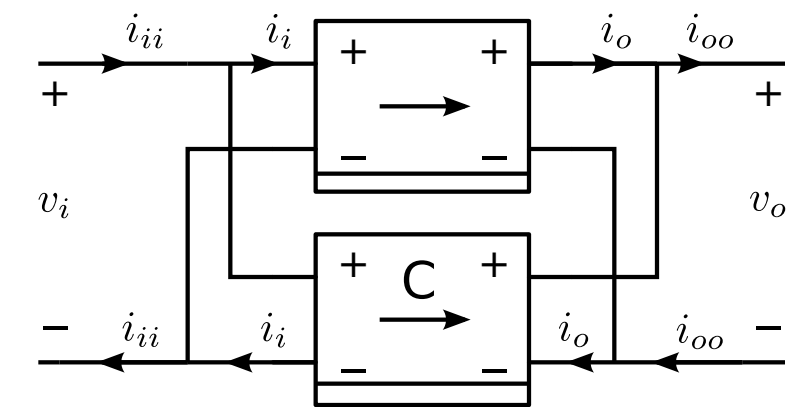
anti-parallel in  
anti-series out



complementary-parallel in  
complementary-series out

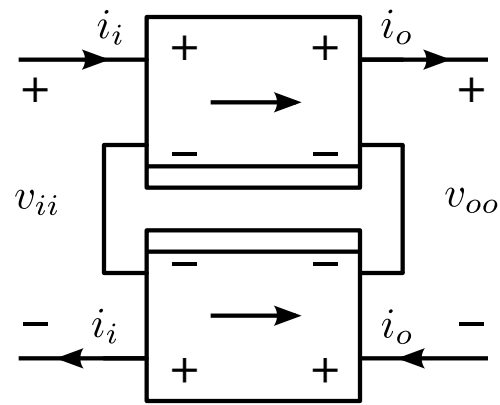


anti-parallel in  
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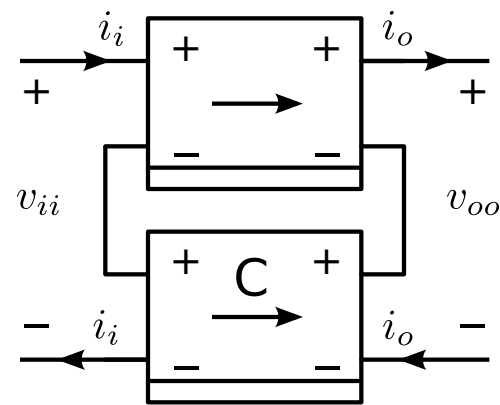


complementary-parallel in  
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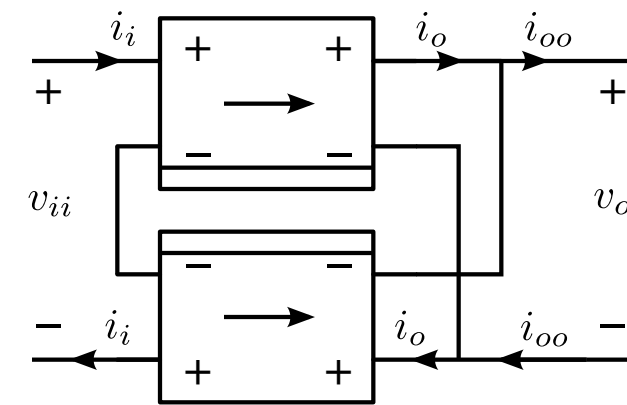
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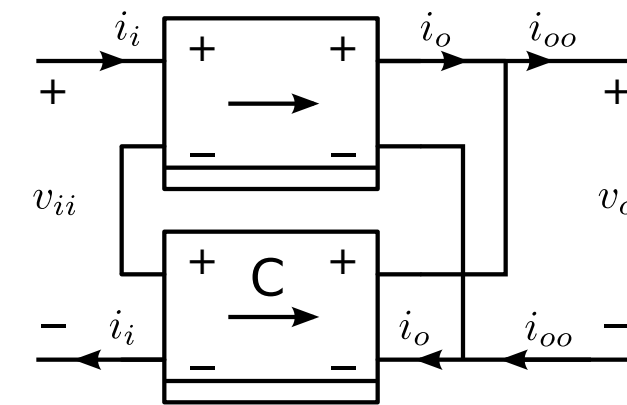
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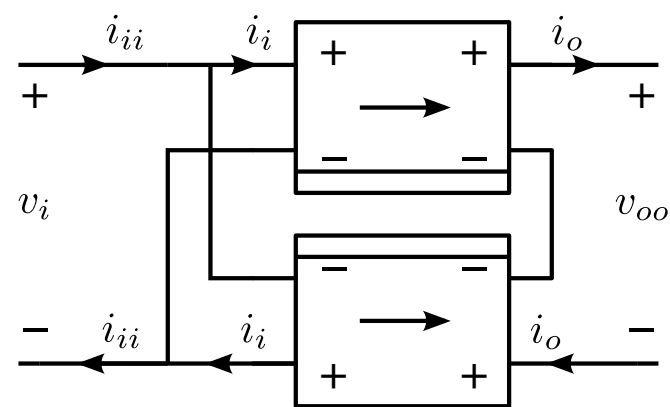
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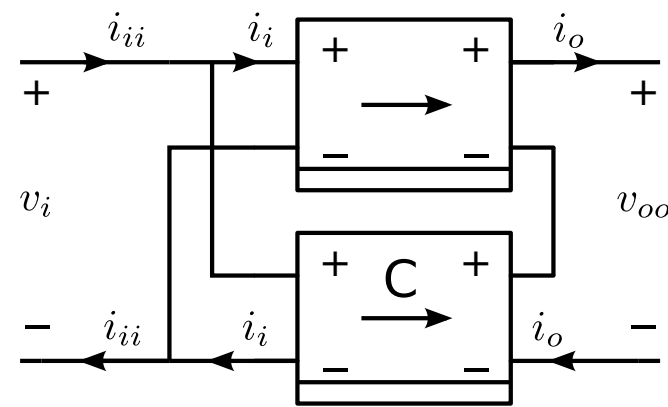
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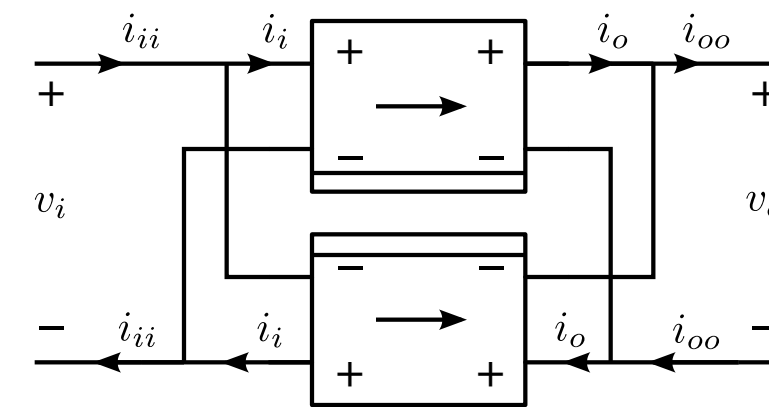
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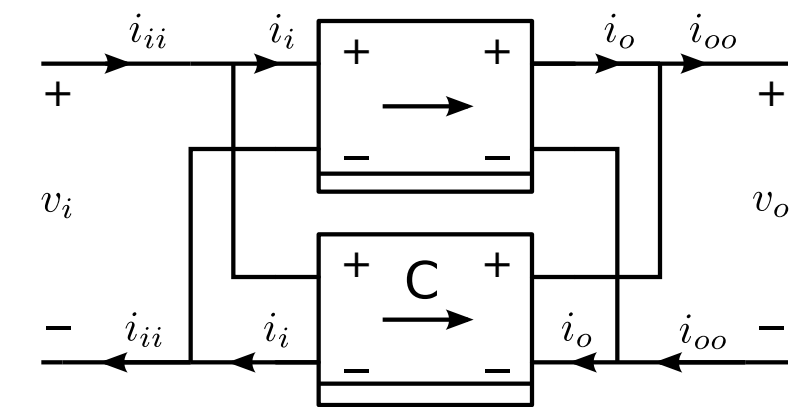
anti-parallel in  
anti-series out



complementary-parallel in  
complementary-series out



anti-parallel in  
anti-parallel out



complementary-parallel in  
complementary-parallel out