Tantárgy: ANALÓG ELEKTRONIKA
Tanár: Dr. Burány Nándor

3. félév

Óraszám: 2+2

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2.5. RÉSZ
TOVÁBBI MŰVELETI ERŐSÍTŐS KAPCSOLÁSOK

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TEXAS INSTRUMENTS

Op Amps For Everyone

Ron Mancini, Editor in Chief

http://focus.ti.com/lit/an/slod006b/slod006b.pdf

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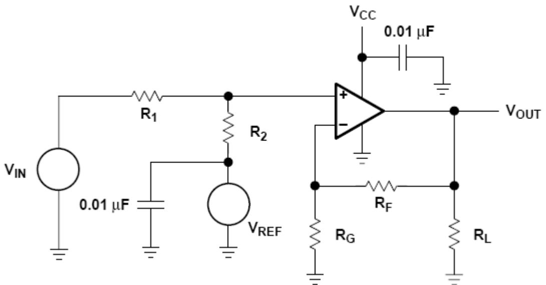
Case 1: $V_{OUT} = +mV_{IN}+b$



$$V_{OUT} = V_{IN}\left(\frac{R_2}{R_1 + R_2}\right)\left(\frac{R_F + R_G}{R_G}\right) + V_{REF}\left(\frac{R_1}{R_1 + R_2}\right)\left(\frac{R_F + R_G}{R_G}\right)$$

$$m = \left(\frac{R_2}{R_1 + R_2}\right)\left(\frac{R_F + R_G}{R_G}\right)$$

$$b = V_{REF}\left(\frac{R_1}{R_1 + R_2}\right)\left(\frac{R_F + R_G}{R_G}\right)$$

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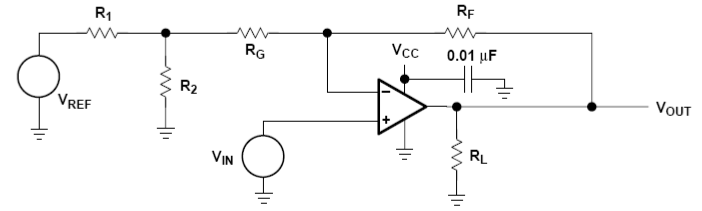
Case 2: $V_{OUT} = +mV_{IN} - b$



$$V_{OUT} = V_{IN}\left(\frac{R_F + R_G + R_1 \parallel R_2}{R_G + R_1 \parallel R_2}\right) - V_{REF}\left(\frac{R_2}{R_1 + R_2}\right)\left(\frac{R_F}{R_G + R_1 \parallel R_2}\right)$$

$$m = \frac{R_F + R_G + R_1 \parallel R_2}{R_G + R_1 \parallel R_2}$$

$$|b| = V_{REF}\left(\frac{R_2}{R_1 + R_2}\right)\left(\frac{R_F}{R_G + R_1 \parallel R_2}\right)$$

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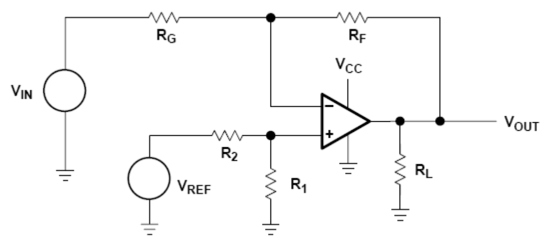
Case 3: $V_{OUT} = -mV_{IN} + b$



$$V_{OUT} = -V_{IN}\left(\frac{R_F}{R_G}\right) + V_{REF}\left(\frac{R_1}{R_1 + R_2}\right)\left(\frac{R_F + R_G}{R_G}\right)$$

$$|m| = \frac{R_F}{R_G}$$

$$b = V_{REF}\left(\frac{R_1}{R_1 + R_2}\right)\left(\frac{R_F + R_G}{R_G}\right)$$

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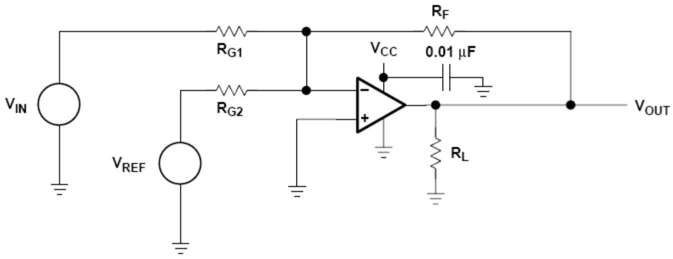
Case 4: $V_{OUT} = -mV_{IN} - b$



$$V_{OUT} = -V_{IN}\frac{R_F}{R_{G1}} - V_{REF}\frac{R_F}{R_{G2}}$$

$$|m| = \frac{R_F}{R_{G1}}$$

$$|b| = V_{REF}\frac{R_F}{R_{G2}}$$

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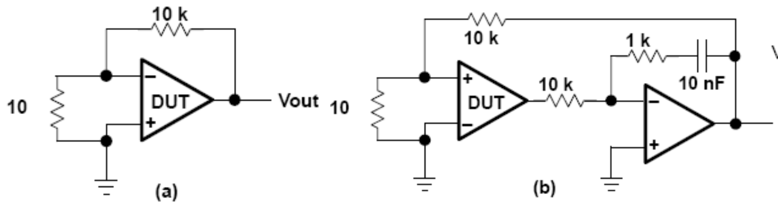
Test Circuits for Input Offset Voltage



$$V_{IO} = \frac{Vout}{1000}$$

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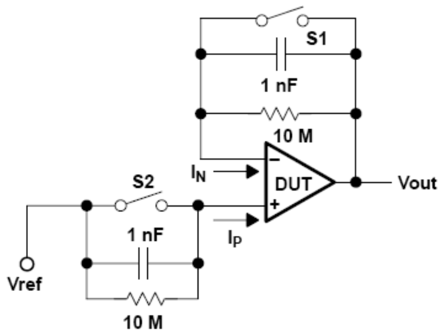
Test Circuit – I_{IB}



S1 Closed

$$I_P = \frac{Vout - Vref}{10^7}$$

S2 Closed

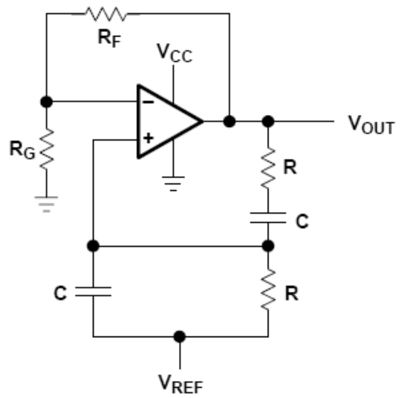
$$I_N = \frac{Vout - Vref}{10^7}$$

Wien Bridge Oscillator

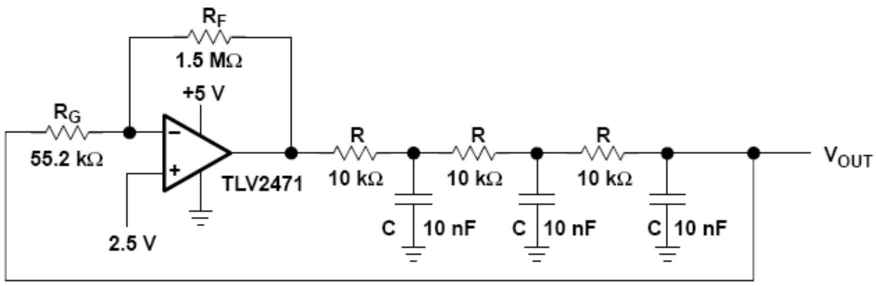
$$V_+ = V_{TEST}\left(\frac{Z_4}{Z_3 + Z_4}\right) = V_{TEST}\left[\frac{\left(\frac{R_2}{R_2C_2s+1}\right)}{\left(\frac{R_2}{R_2C_2s+1}\right) + \left(R_1 + \frac{1}{C_1s}\right)}\right]$$

$$\frac{V_+}{V_{TEST}} = \frac{1}{1 + R_1C_2S + \frac{R_1}{R_2} + \frac{1}{R_2C_1s} + \frac{C_2}{C_1}}$$

$$\frac{V_+}{V_{TEST}} = \frac{1}{1 + \frac{R_1}{R_2} + \frac{C_2}{C_1} + j\left(\frac{\omega_0}{\omega_1} - \frac{\omega_2}{\omega_0}\right)}$$



Phase Shift Oscillator, Single Amplifier



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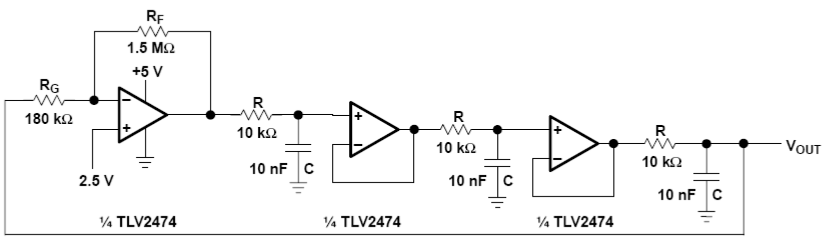
Phase Shift Oscillator, Buffered



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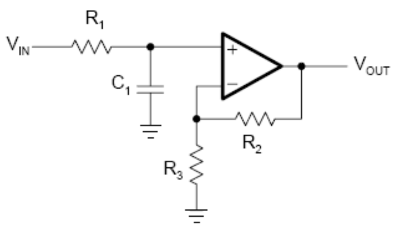
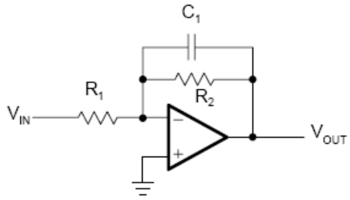
First-Order Low-Pass Filter



First-Order Noninverting Low-Pass Filter



First-Order Inverting Low-Pass Filter

$$A(s) = \frac{1 + \frac{R_2}{R_3}}{1 + \omega_c R_1 C_1 s}$$

$$A(s) = \frac{-\frac{R_2}{R_1}}{1 + \omega_c R_2 C_1 s}$$

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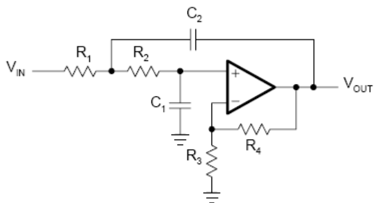
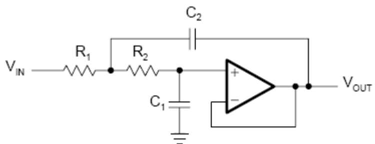
Second-Order Low-Pass Filter



$$A(s) = \frac{A_0}{1 + \omega_c\left[C_1\left(R_1 + R_2\right) + \left(1 - A_0\right) R_1 C_2\right] s + \omega_c{}^2 R_1 R_2 C_1 C_2 s^2}$$



$$A(s) = \frac{1}{1 + \omega_c C_1\left(R_1 + R_2\right) s + \omega_c{}^2 R_1 R_2 C_1 C_2 s^2}$$

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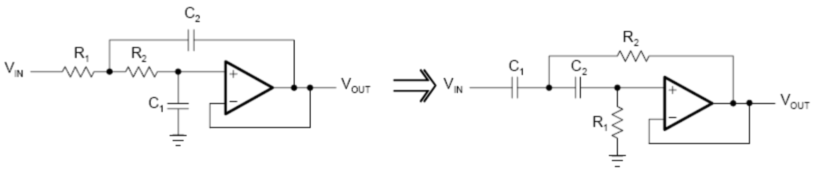
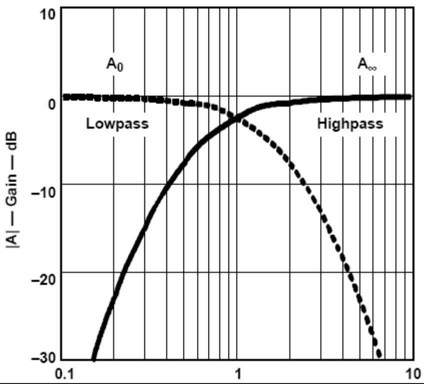
High-Pass Filter Design





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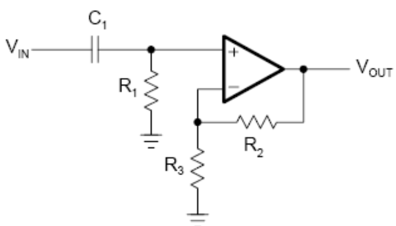
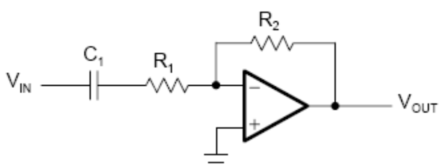
First-Order High-Pass Filter



First-Order Noninverting High-Pass Filter



First-Order Inverting High-Pass Filter

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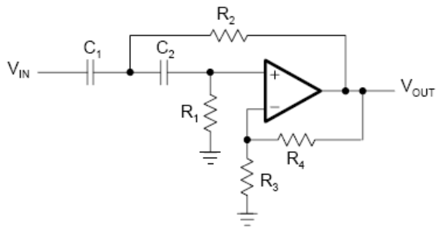
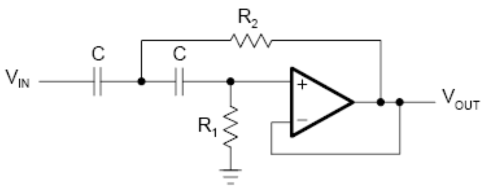
Second-Order High-Pass Filter



$$A(s) = \frac{\alpha}{1 + \frac{R_2(C_1+C_2)+R_1C_2(1-\alpha)}{\omega_c R_1 R_2 C_1 C_2}\cdot\frac{1}{s} + \frac{1}{\omega_c^2 R_1 R_2 C_1 C_2}\cdot\frac{1}{s^2}} \qquad \text{with} \qquad \alpha = 1 + \frac{R_4}{R_3}$$



$$A(s) = \frac{1}{1 + \frac{2}{\omega_c R_1 C}\cdot\frac{1}{s} + \frac{1}{\omega_c^2 R_1 R_2 C^2}\cdot\frac{1}{s^2}}$$

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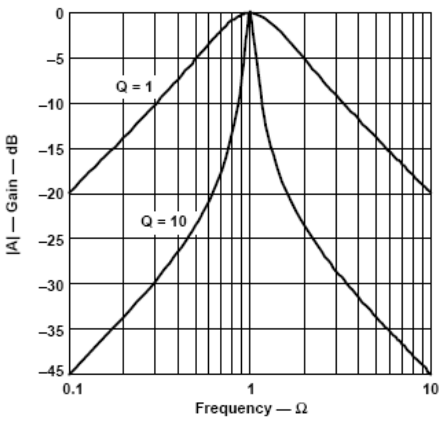
Second-Order Band-Pass Filter

$$A(s) = \frac{\frac{A_m}{Q}\cdot s}{1 + \frac{1}{Q}\cdot s + s^2}$$



Gain Response of a Second-Order Band-Pass Filter

Sallen-Key Band-Pass

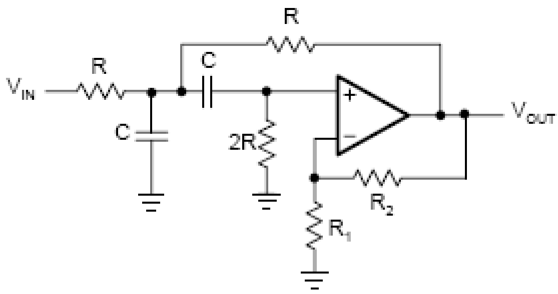
$$A(s) = \frac{G \cdot RC\omega_m \cdot s}{1 + RC\omega_m(3 - G) \cdot s + R^2C^2\omega_m{}^2 \cdot s^2}$$

mid-frequency: $f_m = \frac{1}{2\pi RC}$

inner gain: $G = 1 + \frac{R_2}{R_1}$

gain at f_m: $A_m = \frac{G}{3 - G}$

filter quality: $Q = \frac{1}{3 - G}$



Vége a 2.5. résznek

(TOVÁBBI MŰVELETI ERŐSÍTŐS KAPCSOLÁSOK)

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